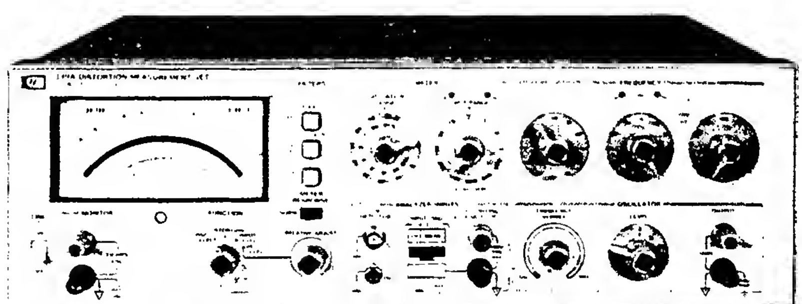
hp 339

OPERATING AND SERVICE MANUAL

DISTORTION MEASUREMENT SET

339A



HEWLETT PACKARD

hp 339A

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OPERATING AND SERVICE MANUAL

MODEL 339A
DISTORTION MEASUREMENT SET

Serial Numbers: 1730A01162 and Greater

IMPORTANT NOTICE

This manual applies directly to instruments with serial number shown on this page. If changes have been made in the instrument since this manual was printed, a "Manual Changes" supplement supplied with this manual will define these changes. Be sure to record this information in your manual. Backdating information contained in Section VII adapts this manual to instruments having serial numbers lower than those shown on this page.

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excessive moisture.

Manual Part No. 00339-90001

Microfiche Part No. 00339-90051

Printed: December 1979

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LIST OF ILLUSTRATIONS

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

 OR 

Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

 OR 

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE:

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains information necessary to install, operate, test, adjust, and service the Hewlett-Packard Model 339A Distortion Measurement Set.

1-3. This section of the manual contains the performance specifications and general operating characteristics of the Model 339A. Also listed are available options and accessories, and instrument and manual identification information.

1-4. SPECIFICATIONS.

1-5. Operating Specifications for the Model 339A are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Table 1-2 lists general operating characteristics of the instrument. These characteristics are not specifications but are typical operating characteristics included as additional information for the user.

1-6. INSTRUMENT AND MANUAL IDENTIFICATION.

1-7. Instrument identification by serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix separated by a letter designating the country in which the instrument was manufactured. (A = U.S.A.; G = West Germany; J = Japan; U = United Kingdom.) The prefix is the same for all identical instruments and changes only when a major instrument change is made. The suffix, however, is assigned sequentially and is unique to each instrument.

1-8. This manual applies to instruments with serial numbers indicated on the title page. If changes have been made in the instrument since the manual was printed, a yellow "Manual Changes" supplement supplied with the manual will define these changes and explain how to adapt the manual to the newer instruments. In addition, backdating information contained in Section VII adapts the manual to instruments with serial numbers lower than those listed on the title page.

1-9. Part numbers for the manual and the microfiche copy of the manual are also listed on the title page.

1-10. DESCRIPTION.

1-11. The Model 339A Distortion Measurement Set combines a low distortion signal source, a high resolution distortion analyzer, an rms responding voltmeter and a VU (volume units) meter in one unit.

1-12. The signal source used in the Model 339A is a "bridged-T" oscillator which provides a low distortion sine-wave signal from 10 Hz to 110 kHz. The output amplitude is variable from 1 mV rms to 3 V rms into a 600 ohm load and is maintained by an amplitude control circuit which minimizes amplitude variations even when changing frequency ranges.

1-13. The distortion analyzer section of the 339A contains a tracking notch filter which is tuned to the oscillator frequency. The analyzer measures total harmonic distortion (THD) from 100% full-scale to .01% full-scale in nine ranges and features both automatic "Set Level" and automatic "Nulling" to greatly simplify operation. The Auto Set Level feature automatically sets the reference level over a 10 dB range. If the input signal is outside this range, a LED on the front panel indicates whether the INPUT RANGE control setting must be increased or decreased to be within the "pull-in" range of the Auto Set Level. The Auto Nulling feature is fully automatic when the 339A internal oscillator is used as the signal source. When an external oscillator is used as the signal source, an LED on the front panel indicates which direction the FREQUENCY controls must be set to be within the Auto Nulling range. Distortion characteristics of the input signal can be monitored at the MONITOR OUTPUT terminals with external equipment (oscilloscope, voltmeter, spectrum analyzer, etc.) to provide additional analysis of the distortion products.

1-14. The Model 339A is equippped with an amplitude modulation (AM) detector which has a frequency response from 550 kHz to 1.6 MHz. The AM detector permits the measurement of modulation distortion.

1-15. The 339A contains three active filters, one high-pass and two low-pass, which enables the user to eliminate unwanted frequencies and noise to permit higher resolution measurements.

1-16. The ac voltmeter section of the 339A measures the rms value of input voltage from 1 mV full-scale to 300 V full-scale in twelve ranges. In the VU meter mode, the

meter response characteristics are changed to those of a volume units meter.

1-17. OPTIONS.

1-18. The following options are available for use with the Model 339A:

Option 907: Front Handle Kit
Option 908: Rack Mounting Kit
Option 909: Front Handle and Rack Mounting Kit
Option 910: Additional Operating and Service Manual

1-19. Recommended Test Equipment.

1-20. Equipment required to maintain the Model 339A is listed in Table 1-3. Other equipment may be substituted if it meets the critical requirements listed in the table.

Table 1-1. Specifications.

DISTORTION

Fundamental Frequency Range:

10 Hz to 110 kHz continuous frequency coverage in 4 decade ranges with 2-digit resolution. Distortion analyzer and oscillator are simultaneously tuned.

Distortion Measurement Range:

0.01% full scale to 100% full scale (-80 dB to 0 dB) in 9 ranges.

Detection and Meter Indication:

True rms detection for waveforms with crest factor ≤ 3. Meter reads dB and % THD (Total Harmonic Distortion). Meter response can be changed from NORMAL to VU ballistics with a front panel switch.

Distortion Measurement Accuracy:

20 Hz to 20 kHz	±1 dB
10 Hz to 50 kHz	+1, -2 dB
50 kHz to 110 kHz	+1.5, -4 dB

NOTE

The above specifications apply for harmonics < 330 kHz.

Fundamental Rejection:

10 Hz to 20 kHz	> 100 dB
20 kHz to 50 kHz	> 90 dB
50 kHz to 110 kHz	> 86 dB

Distortion Introduced by Instrument (Input > 1 V rms)

10 Hz to 20 kHz	< -95 dB
20 kHz to 30 kHz	< -90 dB
30 kHz to 50 kHz	< -85 dB
50 kHz to 110 kHz	< -70 dB

Residual Noise (Fundamental frequency setting < 20 kHz, 80 kHz filter in, source resistance ≤ 1 kΩ shielded):

< -92 dB referenced to 1 V.

Input Level for Distortion Measurements:

30 mV to 300 V rms
(100 mV range minimum)

Input Impedance:

100 kΩ ±1.0% shunted by < 100 pF input High to Low.

DC Isolation:

Input low may be connected to chassis ground or floated 30 V to reduce the effects of ground loops on the measurement.

Auto Set Level:

No set level adjustment required. Distortion measurements are made directly over 10 dB range selected by input range switch. Two LED annunciators provide a fast visual indication to change input range for valid distortion measurement. Correct range is indicated when both annunciators are extinguished.

Auto Null:

Using internal oscillators: No manual frequency tuning necessary when using internal oscillator as signal source. Oscillator frequency controls simultaneously tune the analyzer.

Using external frequency source: Two LED annunciators provide a quick visual indication for the operator to increase or decrease the analyzer frequency controls. When the analyzer is rough tuned to within one least significant digit of the fundamental frequency, the indicator lights are extinguished and the 339A auto-null circuitry takes over to provide a fast accurate null without tedious operator tuning.

Input Filters (usable on all functions):

Low Pass

30 kHz – 3 dB point at 30 kHz, +2.6 kHz, –3 kHz. Provides band limiting required by FCC for proof-of-performance broadcast testing.

80 kHz – 3 dB point at 80 kHz, +7 kHz, –7.9 kHz. Normally used with fundamental frequencies <20 kHz to reduce the effect of higher frequency noise present in the measured signal.

High Pass

400 Hz – 3 dB point at 400 Hz, +35 Hz, –40 Hz. Normally used with fundamental frequencies >1 kHz to reduce the effect of hum components in the input signal.

Monitor Output:

Provides scaled presentation of input signal after

Table 1-1. Specifications (Cont'd).

fundamental is removed for further analysis using oscilloscope or low frequency spectrum analyzer.

Output Voltage: 1 V rms ±5% open circuit for full scale meter indication, proportional to meter deflection.

Output Resistance: 1 kΩ ±5%.

VOLTMETER

Voltage Range:

1 mV rms full scale to 300 V rms full scale (−60 dB to +50 dB full scale, meter calibrated in dBV and dBm into 600 Ω)

Frequency Range:

10 Hz to 110 kHz

Accuracy (% of range setting)

20 Hz to 20 kHz	± 2%
10 Hz to 110 kHz	± 4%

Detection and Meter Indication

True rms detection for waveforms with crest factor ≤ 3. Meter reads true rms volts, dB V, and dBm into 600Ω.

Input Impedance:

100 kΩ ± 1.0% shunted by < 100 pF Input High to Low.

Monitor Output:

Provides scaled presentation of input signal for further analysis using oscilloscope or low frequency spectrum analyzer.

Output Voltage: 1 V rms ±5% open circuit for full scale meter indication, proportional to meter deflection.

Output Resistance: 1 kΩ ± 5%.

RELATIVE INPUT LEVEL

Provides a ratio measurement relative to an operator selected reference level with readout directly in dB V or dBm (600 Ω).

Voltage range, frequency range, accuracy specifications, and monitor are the same as in VOLTMETER mode. (Accuracy is relative to 0 dB set level input.)

OSCILLATOR

Frequency Range:

10 Hz to 110 kHz in 4 overlapping decade ranges with 2 digit resolution. Frequency vernier provides continuous frequency tuning between 2nd digit switch settings.

Output Level:

Variable from < 1 mV to > 3 V rms into 600 Ω with 10 dB/step LEVEL control and 10 dB VERNIER adjustment.

OSC LEVEL position on function switch allows a quick check of oscillator level without disconnecting leads to device under test.

OFF position on Oscillator LEVEL control provides fast signal-to-noise measurement capability. Oscillator output terminals remain terminated in 600Ω.

Frequency Accuracy:

± 2% of selected frequency (with FREQUENCY VERNIER in CAL position).

Level Flatness:

20 Hz to 20 kHz	± 0.1 dB
10 Hz to 110 kHz	± 0.2 db

Distortion (≥ 600 Ω load, ≤ 3 V output):

10 Hz to 20 kHz	< -95 dB (0.0018%) THD
20 kHz to 30 kHz	< -85 dB (0.0056%) THD
30 kHz to 50 kHz	< -80 dB (0.01%) THD
50 kHz to 110 kHz	< -70 dB (0.032%) THD

Output Resistance:

600Ω ± 5%

AM DETECTOR

Frequency Range:

Carrier frequencies: 550 kHz to 1.6 MHz.
Modulation frequencies: 20 Hz to 20 kHz.

Distortion introduced by AM Detector (with 30 kHz filter switched IN):

Up to 85% Modulation: < -36 dB (1.6%) THD
85% to 95% Modulation: < -30 dB (3%) THD

Input Level

Maximum: 60 V peak
Modulation signal level:
2.0 V rms minimum
10 V rms maximum

Monitor Output (with modulated RF carrier applied to AM Detector input):

Table 1-1. Specificatons (Cont'd).

Distortion mode: Provides scaled presentation of demodulated input signal after fundamental is removed.	Voltmeter and Relative Input mode: Provides scaled presentation of demodulated input signal. Output Voltage and Output Resistance are the same as in Distortion mode.

Table 1-2. Typical Operating Characteristics.

GENERAL

Operating Environment:

Temperature: 0°C to 50°C.
Humidity Range. < 95%, 0°C to 40°C.

Storage Temperature:

− 40°C to + 65°C.

Power:

100/120/220/240, +5%, -10%, 40 to 66 Hz, 200 mA max.

Weight:

Net 8.2 kg (18 lbs.); shipping 11.3 kg (25 lbs.).

Dimensions:

426 mm wide x 146 mm high x 442 mm deep (16.75" wide x 5.75" high x 17.4" deep).

Table 1-3. Recommended Test Equipments.

Instrument	Critical Specification	Recommended Model	Use
AC Calibrator	Frequency: 10 Hz - 110 kHz Output Level: 1 mV - 300 V rms Level Accuracy: ± .2% Output Impedance: ≤ 50 Ω	-hp- Model 745A AC Calibrator -hp- Model 746A High Voltage Amplifier	PAT
True RMS Voltmeter	Frequency Range: 10 Hz - 110 kHz Voltage Range: 1 mV - 10 V rms Measurement Accuracy: ± .5% Measurement Resolution: .1% of full-scale Crest Factor: ≥ 4	-hp- Model 3403C True RMS Voltmeter	PT
Pulse Generator	Pulse Output Amplitude: 10 V p-p Pulse Width: Variable, 1 msec − 10 μsec Repetition Rate: 100 Hz − 10 kHz	-hp- Model 8011A Pulse Generator	P
Oscilloscope	Bandwidth: DC - 2 MHz Sweep Time: .1 μs - .5 sec/div Sensitivity: .1 V/div.	-hp- Model 1221A Oscilloscope	PT

Table 1-3. Recommended Test Equipments (Cont'd).

Instrument	Critical Specification	Recommended Model	Use
Frequency Counter	Frequency Range: 10 Hz - 110 kHz Frequency Resolution: .1% of reading	-hp- Model 5300A Counter Mainframe -hp- Model 5302A Counter Module	P
Spectrum Analyzer	Frequency Range: 10 Hz - 330 kHz Frequency Resolution: .1 Hz Input Amplitude: 1 V Dynamic Range: 50 dB Measurement Resolution: ± .1 dB Minimum Bandwidth: 3 Hz	-hp- Model 3044A Spectrum Analyzer	PA
Tuneable Notch Filter	Frequency Range: 10 Hz - 110 kHz Notch Depth: ≥ -80 dB	-hp- Model 339A Distortion Measurement Set	P
Low Distortion Oscillator	Frequency Range: 10 Hz - 110 kHz Output Level: 3 V rms into 600 Ω THD: > -95 dB (10 Hz - 20 kHz) > -85 dB (20 kHz - 30 kHz) > -80 dB (30 kHz - 50 kHz) > -70 dB (50 kHz - 110 kHz)	-hp- Model 239A Oscillator	PAT
DC Digital Voltmeter	Input Range: 4 V dc Measurement Accuracy: ± .1% Resolution: .01% of full-scale	-hp- Model 3465A Digital Voltmeter	AT
Resistors	600 Ω Resistive Load	-hp- Accessory No. 11095A	PA
	600 Ω 1% Metal Film	-hp- Part No. 0698-5405	
	60 kΩ 1% Metal Film	-hp- Part No. 0698-5973	P
	100 kΩ .1% Metal Film	-hp- Part No. 0698-4158	
	1 kΩ 1% Metal Film	-hp- Part No. 0757-0280	

P = Performance Test

A = Adjustment Procedures

T = Troubleshooting

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section of the manual contains information and instructions necessary to install the Model 339A Distortion Measurement Set. Also included are initial inspection procedures, power and grounding requirements, environmental information, and packaging instructions.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected, both mechanically and electrically, before shipment. It should be free of mars and scratches and in perfect electrical order. The instrument should be inspected upon receipt for damage that might have occured in transit. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been mechanically and electrically inspected. Procedures for testing the electrical performance of the Model 339A are given in Section IV of this manual. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the Performance Tests, notify the nearest Hewlett-Packard Office. (A list of the -hp- Sales and Service Offices is presented at the back of this manual.) If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office. Save the shipping materials for the carriers inspection.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

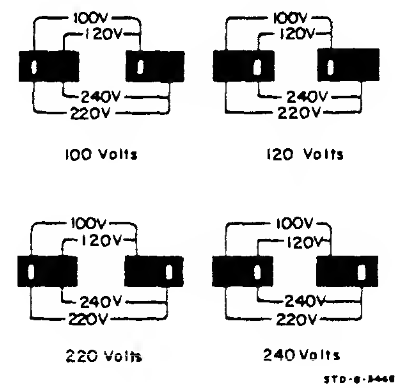
2-7. The Model 339A requires a power source of 100, 120, 220, or 240 V ac (+5% - 10%), 48 Hz to 66 Hz single phase. Maximum power consumption is 48 VA.

2-8. Line Voltage Selection.

2-9. Before connecting ac power to the Model 339A make sure the rear panel line selector switches are set to correspond to the available power line voltage and that the proper fuse is installed, as shown in Figure 2-1. The instrument is shipped from the factory with the line voltage and fuse selected for 120 V ac operation.

2-10. Power Cable.

2-11. Figure 2-2 illustrates the standard configurations used for -hp- power cables. The number directly below each drawing is the -hp- part number for a power cable equipped with a connector of that configuration. If the appropriate power cable is not included with the instrument, notify the nearest -hp- Sales and Service Office and the proper cable will be provided.

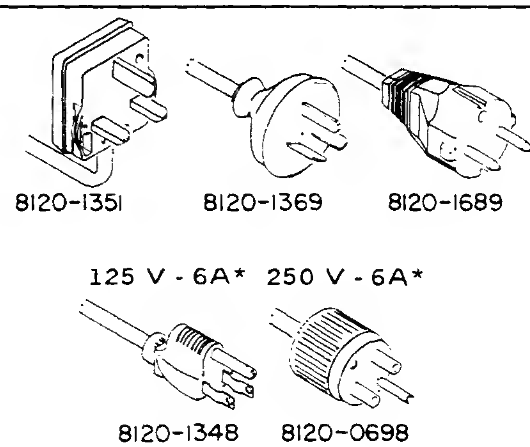


NOMINAL VOLTAGE	OPERATING RANGE - 10%, + 5% of nominal	FUSE
100 volts	90 to 105 volts	0.25 A
120 volts	108 to 126 volts	
220 volts	198 to 231 volts	
240 volts	216 to 252 volts	

Figure 2-1. Line Voltage Selection.

2-12. Grounding Requirements.

2-13. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument cabinet and front panel be grounded. The Model 339A is equipped with a three



*UL LISTED FOR USE IN THE UNITED STATES OF AMERICA

Figure 2-2. Power Cord Configurations.

conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

2-14. Bench Use.

2-15. The Model 339A is shipped with plastic feet and tilt stands installed and is ready for use as a bench instrument. The plastic feet are shaped to permit "stacking" with other full-module Hewlett-Packard instruments. The tilt stands permit the operator to elevate the front of the instrument for operating and viewing convenience.

2-16. Rack Mounting.

2-17. The Model 339A may be rack mounted by adding rack mounting kit Option 908 or Option 909. Option 908 contains the basic hardware and instructions for rack mounting; Option 909 adds front handles to the basic rack mount kit. The rack mount kits are designed to permit the instrument to be installed in a standard 19 inch rack.

2-18. ENVIRONMENTAL REQUIREMENTS.

WARNING

To prevent electrical shock or fire hazard, do not expose the instrument to rain or moisture.

2-19. Operating and Storage Temperature.

2-20. In order to meet the specifications listed in Table 1-1, the instrument should be operated within an ambient temperature range of 0°C to +50°C (+32°F to +122°F).

2-21. The instrument may be stored or shipped where the ambient temperature range is within −40°C to +65°C (−40°F to +149°F). However, the instrument should not be stored or shipped where temperature fluctuations cause condensation within the instrument.

2-22. Humidity.

2-23. The instrument may be operated in environments with relative humidity of up to 95%. However, the instrument must be protected from temperature extremes which cause condensation within the instrument.

2-24. Altitude.

2-25. The instrument may be operated at altitudes up to 4572 meters (15,000 feet).

2-26. REPACKAGING FOR SHIPMENT.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.

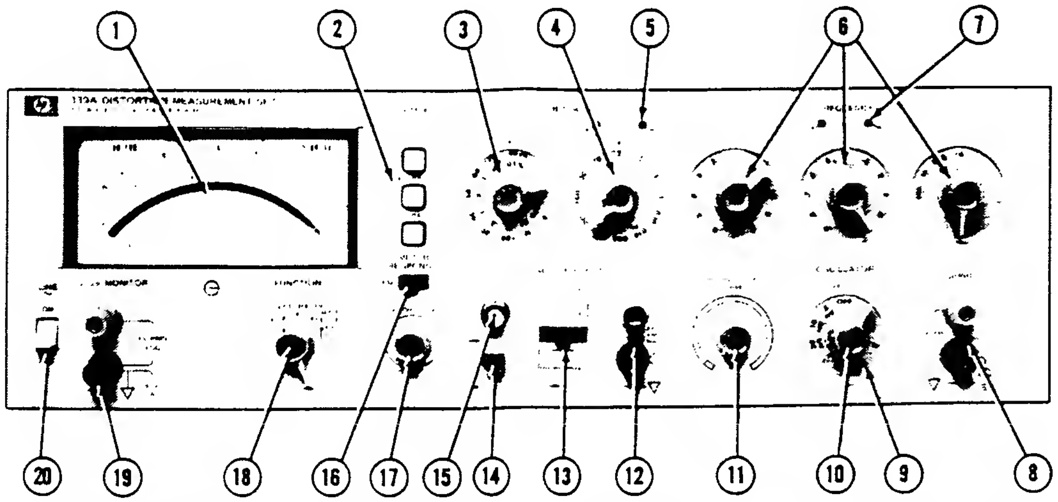
2-27. The following is a general guide for repackaging the instrument for shipment. If the original container is available, place the instrument in the container with appropriate packing material and seal well with strong tape or metal bands. If the original container is not available, proceed as follows:

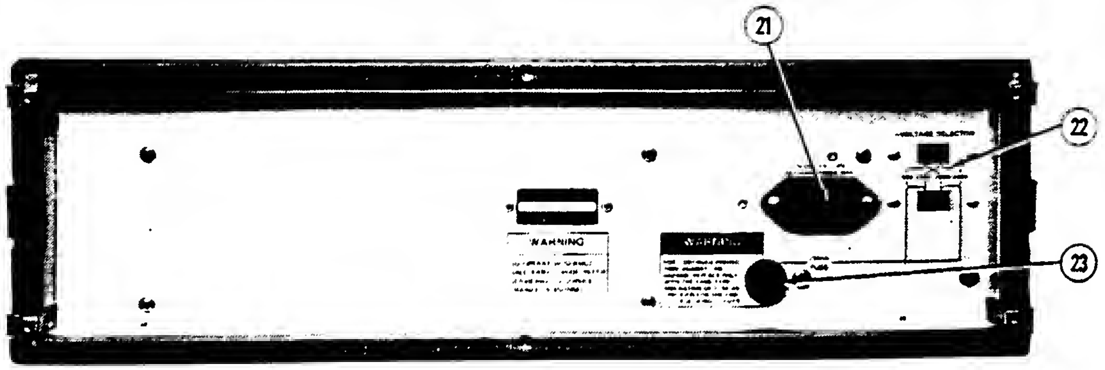
a. Wrap the instrument in heavy paper or plastic before placing it in an inner container.

b. Place packing around all sides of the instrument and protect the front panel with cardboard strips or plastic foam.

c. Place the instrument and inner container in a heavy carton and seal with strong tape or metal bands.

d. Mark the shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.





1. Meter indicates voltage level, distortion in dB or percent, or VU (volume units) in dB.

2. Filters permit the user to eliminate unwanted frequencies and noise from the measurement. The filters include a 400 Hz high-pass filter which is normally used to reject power-line related noise, a 30 kHz low-pass filter for use in making "proof of performance" measurements at AM broadcast stations, and an 80 kHz low-pass filter to eliminate high frequency noise.

3 DISTORTION RANGE control selects the gain of the distortion measurement circuits to the proper sensitivity for measuring the applied signal.

4. INPUT RANGE control sets the input range of the distortion and meter circuits to the proper sensitivity for measuring the applied signal.

5. Input Range indicators indicate the direction the INPUT RANGE control must be turned to select the correct range for the signal applied.

6. FREQUENCY controls determine the fundamental rejection frequency of the analyzer and the output frequency of the oscillator.

7. Frequency indicators indicate the direction the FREQUENCY controls must be turned to bring the analyzer circuits within "pull-in range" of the fundamental frequency of the applied signal. This applies only when using an external signal source.

8. OSCILLATOR OUTPUT terminals. Output impedance is 600 Ω.

9. OSCILLATOR LEVEL control changes the output level in 10 dB V steps from 3 mV rms to 3 V rms into 600 Ω. The LEVEL control also includes an OFF position which disconnects the oscillator output and terminates the output terminals with a 600 Ω resistive load.

10. Oscillator LEVEL Vernier permits the output level to be varied below the level selected by the LEVEL control. This makes the oscillator output level continuously variable from less than 1 mV to greater-than 3 rms into 600 Ω.

11. OSCILLATOR FREQUENCY VERNIER. Frequency range of the vernier permits the oscillator output frequency to be increased above the frequency selected by the FREQUENCY controls. Frequency range of the vernier is approximately equal to one step on the center frequency control.

12. DISTORTION ANALYZER (and voltmeter) terminals provide connection for analyzer and voltmeter inputs.

13. ANALYZER (and voltmeter) INPUT/GND SELECT switch selects DIStortion ANalyzer input with either circuit or chassis ground or AM DETECTOR input with chassis ground only.

14. AM DETECTOR input terminal provides connection for amplitude modulated RF signals.

15. Ground Terminal provides connection to 339A Chassis.

16. METER RESPONSE switch selects normal or VU (volume units) meter response.

17. RELATIVE ADJUST permits the user to set a convenient reference level on the meter when using the voltmeter RELative LEVEL FUNCTION.

18. FUNCTION control selects analyzer or voltmeter functions.

19. MONITOR terminals permit the signal applied to the meter circuitry to be monitored. The MONITOR output is 1 V rms for a full-scale meter deflection.

With an audio signal applied to the DISTORTION ANALYZER input the MONITOR output will be:

DISTORTION FUNCTION - Distortion products of the applied signal after the fundamental has been removed.

INPUT LEVEL - And RELative LEVEL FUNCTIONS. Scaled presentation of the applied signal.

With a modulated RF signal applied to the AM DETECTOR input the MONITOR output will provide:

DISTORTION FUNCTION - Scaled presentation of the demodulated input signal with the fundamental removed.

INPUT LEVEL and RELative LEVEL FUNCTIONS - Scaled presentation of the demodulated input signal.

The MONITOR terminals are disabled when using the OSCillator LEVEL FUNCTION.

20. LINE switch applies ac power to the instrument.

21. AC LINE connector provides connection for ac power.

22. AC VOLTAGE SELECTOR switches set the instrument to operate from 100 V, 120 V, 220 V, or 240 V ac power source.

23. FUSE protects the instrument circuits from excessive current.

Figure 3-1. Control, Connector and Indicator Descriptions.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section contains information and instructions necessary for operation of the Model 339A Distortion Measurement Set. Included is a description of operating characteristics, a description of operating controls and indicators, and functional checks to be performed by the operator.

3-3. OPERATING CHARACTERISTICS.

3-4. General.

3-5. The Model 339A is designed to measure Total Harmonic distortion (THD) of signals having a fundamental frequency between 10 Hz and 110 kHz. the analyzer section of this instrument measures total harmonic distortion levels from 100% (0 dB) full-scale to .01% (-80 dB) full-scale in nine ranges as selected by the DISTORTION RANGE control. to simplify operation, the analyzer section features both automatic "set level" and automatic "nulling".

3-6. The Auto Set Level feature automatically sets the measurement reference level over a 10 dB V range. If the input signal is outside this range, an LED on the front panel indicates whether the INPUT RANGE control setting must be increased or decreased to be within the "pull-in" range of the Auto Set Level.

3-7. The Auto Nulling feature is fully automatic when the 339A internal oscillator is used as the signal source. When using an external signal source, an LED on the front panel indicates which direction the FREQUENCY controls must be rotated to be within the Auto Nulling range.

3-8. The Model 339A includes an AM detector which has a carrier frequency range of 550 kHz to 1.6 MHz. The AM detector permits the measurement of THD of a modulation signal.

3-9. The signal source used in the Model 339A is a "bridged T" oscillator which provides a low distortion sine-wave signal from 10 Hz to 110 kHz. The operating frequencies of the oscillator and the analyzer notch filter are set simultaneously. The output level of the oscillator is variable from 1 mV rms full-scale to 3 V rms full-scale into a 600 Ω load.

3-10. The ac voltmeter section of the Model 339A measures the true rms value of input voltages from 1 mV full-scale to 300 V full-scale in twelve ranges. Frequency response of the meter section is 10 Hz to 110 kHz.

3-11. True RMS VS Average Responding Detection.

3-12. Since the 339A employs a true rms converter to detect the measurement signal, it is less susceptible to errors than average responding devices. Most average responding meters are calibrated to indicate the rms value of a pure sine-wave. When reading a pure sine-wave, both the true rms and average responding meters will give the correct indication. However, when reading complex signals the average responding meter may be in error. The amount or error depends upon the particular signal being measured.

As an example; when measuring a square-wave, the true rms meter will give the correct indication of the rms value. The average responding meter however, will read 11% high. The average responding meter is also affected by signals with harmonic content. The amount of error introduced by an average responding meter due to harmonics is dependent upon the relative amplitude, phase, and order of the harmonic. The third harmonic usually causes the greatest amount of error. For example, when measuring a signal with third harmonic content, an average responding meter can be in error by +5% to -20% depending upon the amplitude and phase of the harmonic, relative to the fundamental frequency. Due to the errors inherent in average responding meters, a distortion analyzer which employs this type of detector will also be subject to the same measurement errors. These errors can cause indicated distortion readings to be as much as 1.3 dB below the actual rms value for certain combinations of second and third harmonics. The Model 339A is not affected by the errors associated with average responding detectors and will provide more accurate measurement indications.

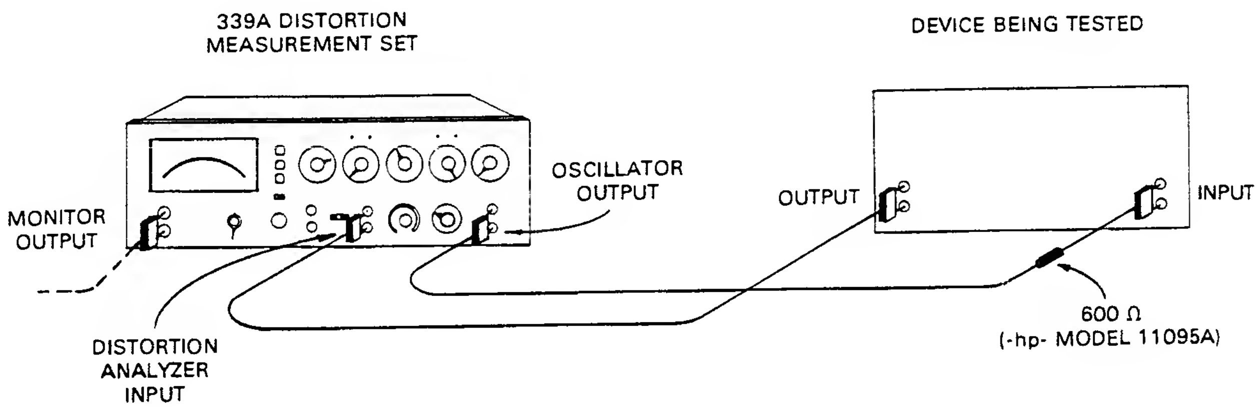
3-13. Turn-On and Warm-Up.

3-14. Before connecting ac power to the 339A, be certain the rear panel voltage selector switches are set to correspond to the voltage of the available power line and that the proper fuse is installed for the voltage selected. For rated measurement accuracy, the 339A should be allowed to "warm-up" for at least 15 minutes.

3-15. DISTORTION MEASUREMENT.

3-16. Distortion Measurement Using the 339A Internal Oscillator.

3-17. The Model 339A Distortion Measurment Set is designed to provide complete capability for measuring Total Harmonic Distortion by combining an automatic, high resolution distortion analyzer and a low distortion signal source. Figure 3-2 illustrates the fundamental application of the Model 339A. The figure shows the equipment configuration and includes an operating procedure for making THD measurements.



PRELIMINARY ADJUSTMENTS.

a. Set the OSCILLATOR LEVEL control to OFF.

b. Set the METER RESPONSE switch to NORMal.

c. Set the ANALYZER INPUT/GND SELECT switch to DIStortion ANalyzer. (Low input connected to chassis ground or floated as desired.)

d. Set FILTER switches as desired.

e. Connect the 339A DISTORTION MEASUREMENT SET and the device to be tested as shown.

OSCILLATOR ADJUSTMENT.

f. Set the FUNCTION switch to OSCillator LEVEL and adjust the OSCILLATOR LEVEL and LEVEL vernier controls for the desired signal level as indicated on the meter. (Change the METER INPUT RANGE switch as necesary to obtain the proper meter range.)

g. Set the FREQUENCY controls and FREQUENCY VERNIER for the desired output frequency. (Use a frequency counter if frequency is critical.)

ANALYZER ADJUSTMENT.

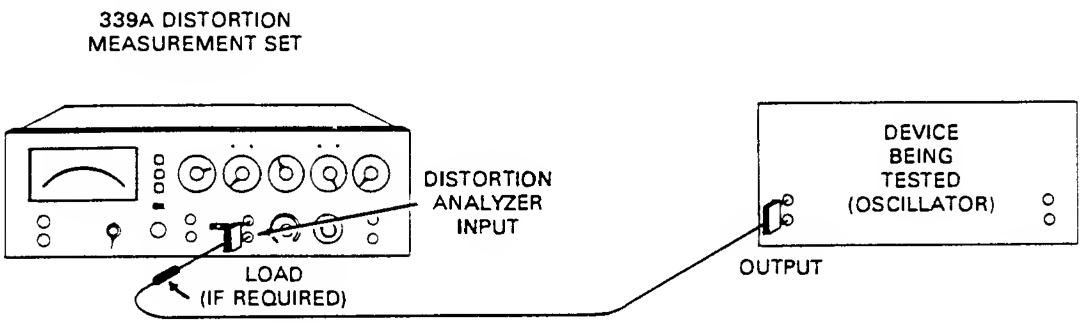
h. Set the FUNCTION switch to DISTORTION.

i. Select the proper input range by turning the METER INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights. The proper input range has been selected when the INPUT RANGE control is set to the lowest range which extinguishes *both* indicator lights.

j. Adjust the DISTORTION RANGE control to obtain an "on-scale" meter indication as near full-scale as possible.

k. Read the amount of total harmonic distortion (THD) in dB by adding the dB figure on the DISTORTION RANGE control and the dB reading of the meter, or the amount of THD in per-cent is indicated by the meter reading (second or third scale) relative to the full-scale per-cent figure on the DISTORTION RANGE control.

Figure 3-2. Distortion Measurement Using 339A Internal Oscillator.



PRELIMINARY ADJUSTMENTS.

a. Set the METER RESPONSE switch to NORMAL.

b. Set the ANALYZER INPUT/GND SELECT switch to DIStortion ANalyzer. (Low input connected to chassis ground or floated as desired.)

c. Set the FILTER switches as desired.

d. Connect the 339A DISTORTION MEASUREMENT SET and the device to be tested as shown.

ANALYZER ADJUSTMENTS.

e. Set the FUNCTION switch to DISTORTION.

f. Select the proper input range by turning the METER INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights. The proper input range has been selected when the INPUT RANGE control is set to the lowest range which extinguishes *both* indicator lights.

g. Slowly adjust the FREQUENCY controls in the direction indicated by the FREQUENCY indicator lights. The proper frequency range has been selected when *both* indicator lights are extinguished.

h. Adjust the DISTORTION RANGE control to obtain an "on-scale" meter indication as near full-scale as possible.

i. Read the amount of total harmonic distortion (THD) in dB by adding the dB figure on the DISTORTION RANGE control and the dB reading of the meter, or the amount of THD in per-cent is indicated by the meter reading (second or third scale) relative to the full-scale per-cent figure on the DISTORTION RANGE control.

Figure 3-3. Distortion Measurement of an External Source.

3-18. Distortion Measurement of an External Source.

Figure 3-3 shows another measurement application. In this case the Model 339A is used to measure the THD of a signal source. The figure includes an illustration of the necesary equipment connections and an operating procedure for making the measurement.

3-20. AM DETECTOR.

3-21. The Model 339A includes an AM DETECTOR to permit the user to measure the total harmonic distortion of a modulation signal on an RF carrier. Equipment connection and measurement procedures are similar to those outlined in Figure 3-3 except the input is connected to the AM DETECTOR input.

3-22. VOLTMETER OPERATION.

3-23. The following procedures outline the operating procedures for the various voltmeter functions.

3-24. Normal Voltmeter Operation.

3-25. To use the Model 339A as a normal, true rms voltmeter, proceed as follows:

a. Set the FUNCTION switch to INPUT LEVEL.

b. Set the METER RESPONSE switch to NORMAL.

c. Set the INPUT/GND SELECT switch to DIStortion ANalyzer (low input connected to chassis ground or floating as desired).

d. Set the FILTER switches off (out).

e. Connect the signal to be measured to the DISTORTION ANALYZER input connectors.

f. Adjust the INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights until an "on-scale" meter indication, as near full-scale as possible, is obtained. (Both indicator lights will be off.)

3-26. RELATIVE LEVEL OPERATION.

3-27. The RELATIVE LEVEL FUNCTION permits the user to adjust the meter gain of the 339A to set a convenient reference level on the meter (usually 0 dB). This function is convenient for measuring signal levels relative to a reference level. To use the RELative LEVEL FUNCTION, proceed as follows:

a. Set the FUNCTION switch to RELative LEVEL.

b. Set the METER RESPONSE switch to NORMal.

c. Set the INPUT/GND SELECT switch to DIStortion ANalyzer. (Low input connected to chassis ground or floating as desired.)

d. Set the FILTER switches off (out).

e. Connect the reference signal to the DISTORTION ANALYZER input connectors.

f. Adjust the INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights until an "on-scale" meter indication is obtained.

g. Use the RELATIVE ADJUST control to set the meter to the desired reference level.

h. Measure other input levels relative to the reference just established. Do not change the RELATIVE ADJUST control.

3-28. Oscillator Level Operation.

3-29. In the OSCillator LEVEL function, the analyzer inputs and the MONITOR output is disabled and the 339A meter circuit is used to monitor the output level of the oscillator. To measure the oscillator output level, perform the following:

a. Set the FUNCTION switch to OSCillator LEVEL.

b. Set the METER RESPONSE switch to NORMAL.

c. Set the FILTER switches to off (out).

d. Adjust the INPUT RANGE control as necessary to obtain an "on-scale" meter indication as near full-scale as possible.

e. The meter reading, relative to the meter range selected by the INPUT RANGE control indicates the output level of the oscillator.

3-30. To adjust the oscillator output to a particular level, perform the following:

a. Set the FUNCTION switch to OSCillator LEVEL.

b. Set the METER RESPONSE switch to NORMAL.

c. Set the FILTER switches to off (out).

d. Set the INPUT RANGE control to the appropriate meter range for the oscillator output level desired.

e. Adjust the OSCILLATOR LEVEL control and LEVEL vernier until the desired output level is indicated on the meter.

3-31. VU MEASUREMENTS.

3-32. To measure volume units (VU), the meter response characteristics are changed to those of a VU meter by switching the METER RESPONSE switch to the VU position. VU measurements can be made in the INPUT LEVEL or RELative LEVEL functions. Measurement results are normally read on the dBm 600 ohms meter scale. Operating procedures for making VU measurements are the same as those listed for Normal Voltmeter Operation or Relative Level Operation.

3-33. Filters.

3-34. Three 60 dB/decade active filters, one high-pass and two low-pass, are included to permit the user to eliminate unwanted frequencies and noise. These filters may be selected individually or in any combination by means of the front panel FILTER switch. The frequencies labeled beside each switch indicate the 3 dB "roll-off" point of that particular filter.

3-35. Input Ground Select.

3-36. The ANALYZER Low input reference is selected by the INPUT/GND SELECT switch. When using the DISTORTION ANALYZER input, the input low is connected to chassis ground (center switch position) or allowed to float (right switch position). When using the AM DETECTOR input (left switch position) the input low is connected to chassis ground.

CAUTION

To prevent damage to the analyzer input circuits, do not float the low input terminal more than ± 30 V dc relative to earth ground.

3-37. Monitor Output.

3-38. The MONITOR output provides a means of driving external equipment to permit a more detailed analysis of the signal being measured. Instruments, such as an oscilloscope, wave analyzer, or spectrum annalyzer can be used to determine the nature of the total harmonic distortion being measured. The monitor output level is 1 V rms for full-scale meter deflection. The MONITOR output is disabled when using the OSCillator LEVEL FUNCTION.

3-39. OSCILLATOR OPERATION.

3-40. Frequency Selection.

3-41. The oscillator frequency is determined by the setting of the FREQUENCY and FREQUENCY VERNIER controls. The units and tenths controls determine the first and second digits of the desired frequency. These numbers are then multiplied by the range selected on the multiplier control. As an example: to set the oscillator to a frequency of 5.6 kHz; set the units control to 5, the tenths control to .6, and the multiplier to X1K. (The FREQUENCY VERNIER should be set to the CAL position.) The FREQUENCY VERNIER provides continuous frequency tuning between steps of the tenths control to permit continuous frequency selection from 10 Hz to 110 kHz.

3-42. Output Level.

3-43. The oscillator output level is controlled by the OSCILLATOR LEVEL control and LEVEL vernier. The OSCILLATOR LEVEL control selects output levels from 3 mV rms full-scale to 3 V rms full-scale in 10 dB V steps (600 ohm load). The level vernier varies the output level from greater than 3 V rms to less than 1 mV rms (600 ohm load).

3-44. OPERATIONAL VERIFICATION CHECKS.

3-45. The following procedures are designed to test the operational capabilities of the Model 339A. If so desired, these tests can be substituted for the performance tests outlined in Section IV for incoming inspection tests or to check operation after calibration. Keep in mind however, these tests check only the operational capabilities of the Models 339A. They *do not* check the performance accuracy. If the instrument fails any of the following tests, refer service to qualified service personnel.

3-46. Preliminary Procedure.

3-47. Before connecting power to the 339A, perform the following:

a. Be certain that the rear panel VOLTAGE SELECTOR switches are set to correspond to the available power line voltage and that the proper fuse is installed.

b. Connect power to the 339A and turn the LINE switch ON.

c. Set the FILTER switches off (out).

d. Set the METER RESPONSE switch to NORMAL.

3-48. OSCILLATOR.

3-49. This procedure checks the output level of the 339A oscillator for all frequency settings. Frequency accuracy is not checked. To check the oscillator proceed as follows:

a. Set the FUNCTION switch to OSCillator LEVEL.

b. Set the INPUT RANGE control to the 10 volt range.

c. Set the FREQUENCY controls fully counterclockwise.

d. Set the OSCILLATOR LEVEL control and level vernier fully clockwise. The meter should indicate more than 6 volts.

e. Set the level vernier fully counterclockwise. The meter should indicate less than 2 volts.

f. Set the INPUT RANGE control to the +10 dBm range and adjust the level vernier for a 0 dBm meter indication (blue scale).

g. While observing the meter, set the FREQUENCY controls to each dial position. (Allow time for the meter reading to stabilize at each setting.) The meter indication should not vary more than 0.6 dBm from the original setting.

h. Set the FREQUENCY controls for a frequency of 1 kHz.

i. Adjust the level vernier for a meter indication 0 dBm.

j. Simultaneously down-range the OSCILLATOR LEVEL and INPUT RANGE controls to the next lower range. The meter should indicate 0 dBm.

k. Repeat Steps i and j for each position of the OSCILLATOR LEVEL control.

3-50. AC VOLTMETER.

3-51. The following procedure checks the ac voltmeter functions and ranges. Perform the following steps:

a. Set the FILTER switches off (out), the METER RESPONSE switch to NORMAL, and the INPUT/GND SELECT switch to the center position. (DIStortion ANalyzer with input low connected to chassis ground.)

b. Set the FUNCTION switch to INPUT LEVEL.

c. Set the INPUT RANGE control to the 10 volt range.

d. Set the FREQUENCY controls for a frequency of 1 kHz.

e. Set the OSCILLATOR LEVEL control to the 3 volt range.

f. Connect a cable from the OSCILLATOR OUTPUT terminals to the DISTORTION ANALYZER input terminals.

g. Adjust the OSCILLATOR LEVEL vernier for a meter indication of 6 volts.

h. While observing the meter, set the INPUT RANGE control to the 30, 100, and 300 volts ranges. The meter should indicate 6 volts on the respective ranges. The left hand INPUT RANGE indicator light should be lit on all three ranges.

i. Set the INPUT RANGE switch to the 3 volt range. Observe that the right hand INPUT RANGE indicator is lit.

j. Down-range the OSCILLATOR LEVEL control to the next lower range and adjust the level vernier for a meter indication -10 dB V.

k. Down-range the INPUT RANGE control to the next lower range. The meter should indicate 0 dB V ± .2 dB V.

l. Repeat Steps j and k until all input ranges except the .001 V range have been checked.

m. Set the INPUT RANGE control to the 10 volt range and the OSCILLATOR LEVEL control to the 3 volt range.

n. Adjust the level vernier for a meter indication of -12 dB V.

o. Set the FUNCTION switch to the RELATIVE LEVEL position.

p. Vary the RELATIVE ADJUST control to verify an adjustment range of greater-than 10 dB V.

3-52. Distortion Analyzer.

3-53. The following procedure checks the distortion analyzer ranges and distortion measurement capability. Perform the following steps:

a. Set the FILTER switches off (out), the METER RESPONSE switch to NORMAL, and the INPUT/GND SELECT switch to the center position (DIStortion ANalyzer with input low connected to chassis ground).

b. Set the DISTORTION RANGE control to 0 dB.

c. Set the INPUT RANGE control to the 1 volt range.

d. Set the FREQUENCY controls to a frequency of 1 kHz.

e. Set the OSCILLATOR LEVEL control to the 3 volt range.

f. Connect a cable between the OSCILLATOR OUTPUT terminals and the DISTORTION ANALYZER input terminals.

g. Set the FUNCTION switch to the DISTORTION position.

h. Adjust the OSCILLATOR LEVEL vernier for a meter indication of -15 dB V.

i. Down-range the DISTORTION RANGE control to the next lower range. The meter should indicate approximately -5 dB V.

j. Repeat Steps h and i until all distortion ranges have been checked.

3-54. Filters.

3-55. The following procedure checks the "roll-off" of the filters.

a. Set the FUNCTION switch to OSCILLATOR LEVEL.

b. Set the INPUT RANGE control to the 3 volt range.

c. Set the OSCILLATOR LEVEL control to the 3 volt range and adjust the level vernier for a meter indication of 0 dB V.

d. Set the FREQUENCY controls for a frequency of 400 Hz.

e. Set the 400 Hz FILTER switch on (in). The meter should indicate -3 dB V ± 1 dB. Return the filter switch to off (out).

f. Set the FREQUENCY controls for a frequency of 30 kHz. Readjust the level vernier for a meter indication 0 dB V if necessary.

g. Set the 30 kHz filter switch on (in). The meter

should indicate -3 dB V ± 2 dB. Return the filter switch to off (out).

h. Set the FREQUENCY controls for a frequency of 80 kHz. Readjust the level vernier for a meter indication of 0 dB V if necessary.

i. Set the 80 kHz filter switch on (in). The meter should indicate -3 dB V ± 2 dB. Return the filter switch to off (out).

3-56. OPERATOR'S MAINTENANCE.

3-57. Fuse Replacement.

3-58. The ac line fuse is located on the rear panel of the instrument. Before checking or replacing the fuse, disconnect the ac line cord from the instrument. The fuse used in the Model 339A is a 250 mA, normal-blow fuse.

WARNING

For continued protection against fire hazard, replace only with the same type and rating of fuse as specified for the line voltage being used.

3-59. Adjustment of Meter Mechanical Zero.

3-60. The meter is properly zero-set when the pointer rests over the zero calibration mark with the instrument in its normal operating environment and turned off. Zero-set the meter as follows to obtain maximum accuracy and mechanical stability:

a. Turn instrument on and alow it to operate for at least 20 minutes to let meter movement reach normal operating temperature.

b. Turn instrument off and allow 30 seconds for all capacitors to discharge.

c. Rotate zero adjustment screw clockwise until pointer is left of zero and moving upscale.

d. Continue rotating screw clockwise; stop when pointer is exactly at zero.

e. When pointer is exactly over zero, rotate adjustment screw slightly counterclockwise to relieve tension on pointer suspension. If pointer moves off zero, repeat Steps c through e, but make counterclockwise rotation less.

SECTION IV
PERFORMANCE TEST

4-1. INTRODUCTION.

4-2. This section contains performance test procedures which can be used to verify that the Model 339A meets the specifications listed in Table 1-1. All tests can be performed without access to the interior of the instrument. A simpler operational verification procedure, included in Section III, may be used to check the operational capability of the 339A. The operational procedures do not, however, check specified accuracy of the instrument.

4-3. EQUIPMENT REQUIRED.

4-4. The test equipment required for the performance tests is listed at the beginning of each procedure and in the Recommended Test Equipment Table in Section I. If the recommended equipment is not available, any equipment that meets the critical specifications given in the table may be substituted.

4-5. TEST RECORD.

4-6. A Performance Test Record is included at the end of this section for your convenience in recording performance data. This record may be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance test. The Performance Test Record may be reproduced without written permission of Hewlett-Packard.

4-7. CALIBRATION CYCLE.

4-8. The Model 339A requires periodic verification of performance. The performance should be tested as part of the incoming inspection and at 90 day or 6 month intervals, depending upon the environmental conditions and your specific accuracy requirements.

4-9. VOLTMETER PERFORMANCE TESTS.

4-10. The following procedures check the accuracy of the voltmeter section of the 339A. These procedures should be performed and the voltmeter accuracy verified before performing the Distortion Analyzer Performance Tests.

4-11. Full-Scale Accuracy and Frequency Response Test.

Equipment Required:

AC Calibrator (-hp- Model 745A)
High Voltage Amplifier (-hp- Model 746A)

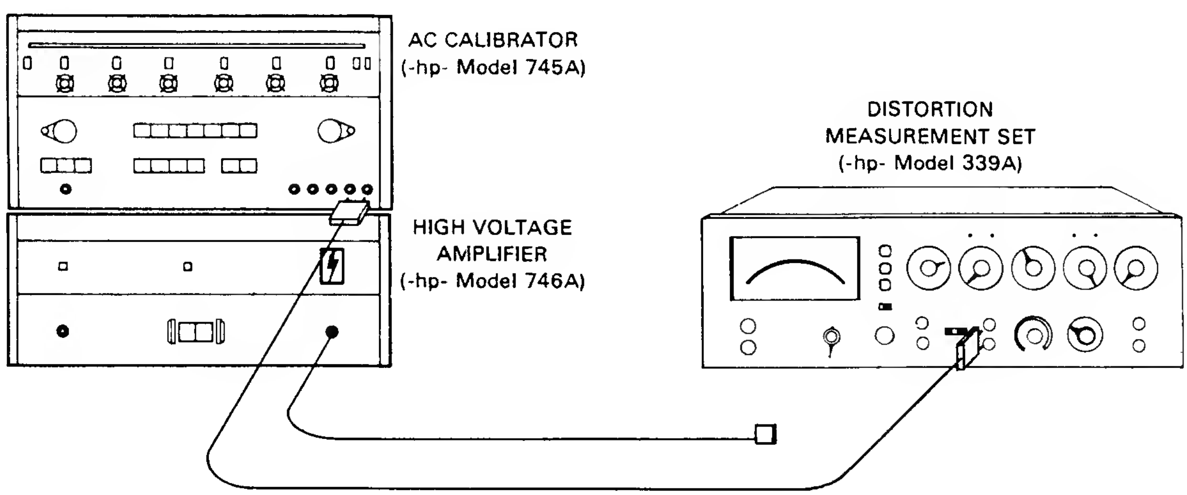


Figure 4-1. Full-Scale Accuracy and Frequency Response Test.

Table 4-1. Full-Scale Accuracy and Frequency Response Test Limits.

Input Range & Input Level	FREQUENCY 10 Hz	20 Hz	100 Hz	1 kHz	10 kHz	20 kHz	110 kHz
	TEST LIMITS						
.001 V	.00096 - .00104	.00098 - .00102					.00096 - .00104
.003 V	.00288 - .00312	.00294 - .00306					.00288 - .00312
.01 V	.0096 - .0104	.0098 - .0102					.0096 - .0104
.03 V	.0288 - .0312	.0294 - .0306					.0288 - .0312
.1 V	.096 - .104	.098 - .102					.096 - .104
.3 V	.288 - .312	.294 - .306					.288 - .312
1 V	.96 - 1.04	.98 - 1.02					.96 - 1.04
3 V	2.88 - 3.12	2.94 - 3.06					2.88 - 3.12
10 V	9.6 - 10.4	9.8 - 10.2					9.6 - 10.4
30 V	28.8 - 31.2	29.4 - 30.6					28.8 - 31.2
100 V	96 - 104	98 - 102					96 - 104
300 V	288 - 312	294 – 306					288 - 312

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE ....001 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Set the AC Calibrator controls for an output of 1 mV, 10 Hz.

c. Connect the output of the AC Calibrator to the 339A DISTORTION ANALYZER input.

d. The 339A 1 mV, 10 Hz meter indication should be within the Test Limits listed in Table 4-1.

e. Using the AC Calibrator and High Voltage Amplifier, verify the 339A Voltmeter accuracy for each Test Frequency, Input Level, and 339A Input Range listed in Table 4-1.

4-12. Meter Tracking and Monitor Output Accuracy Test.

Equipment Required:

AC Calibrator (-hp- Model 745A)
True RMS Voltmeter (-hp- Model 3403C)

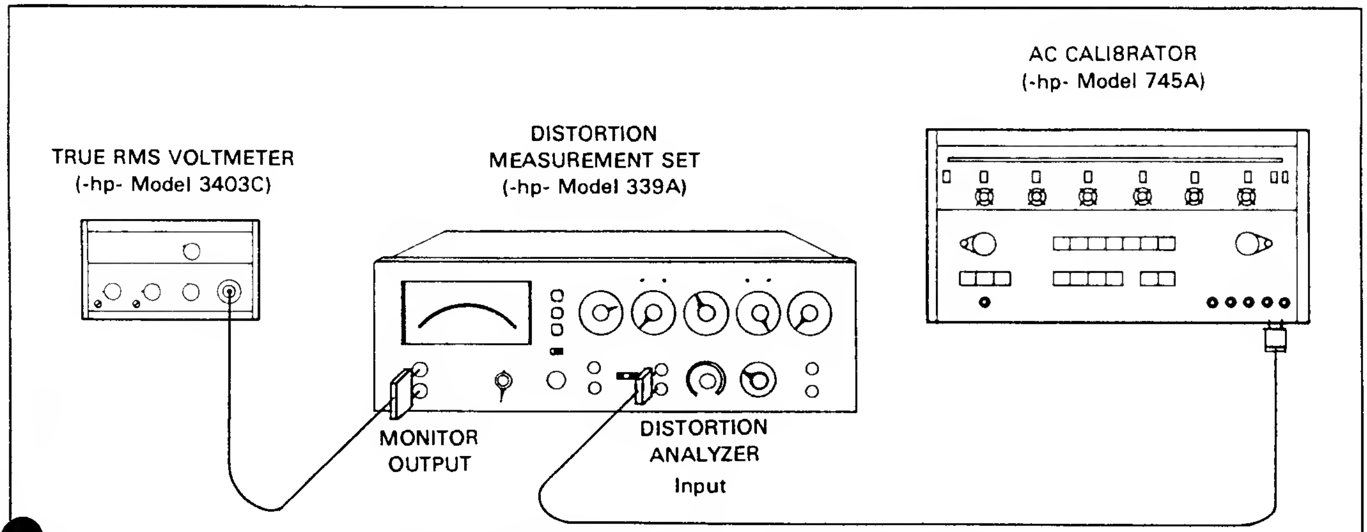


Figure 4-2. Meter Tracking and Monitor Output Accuracy Test.

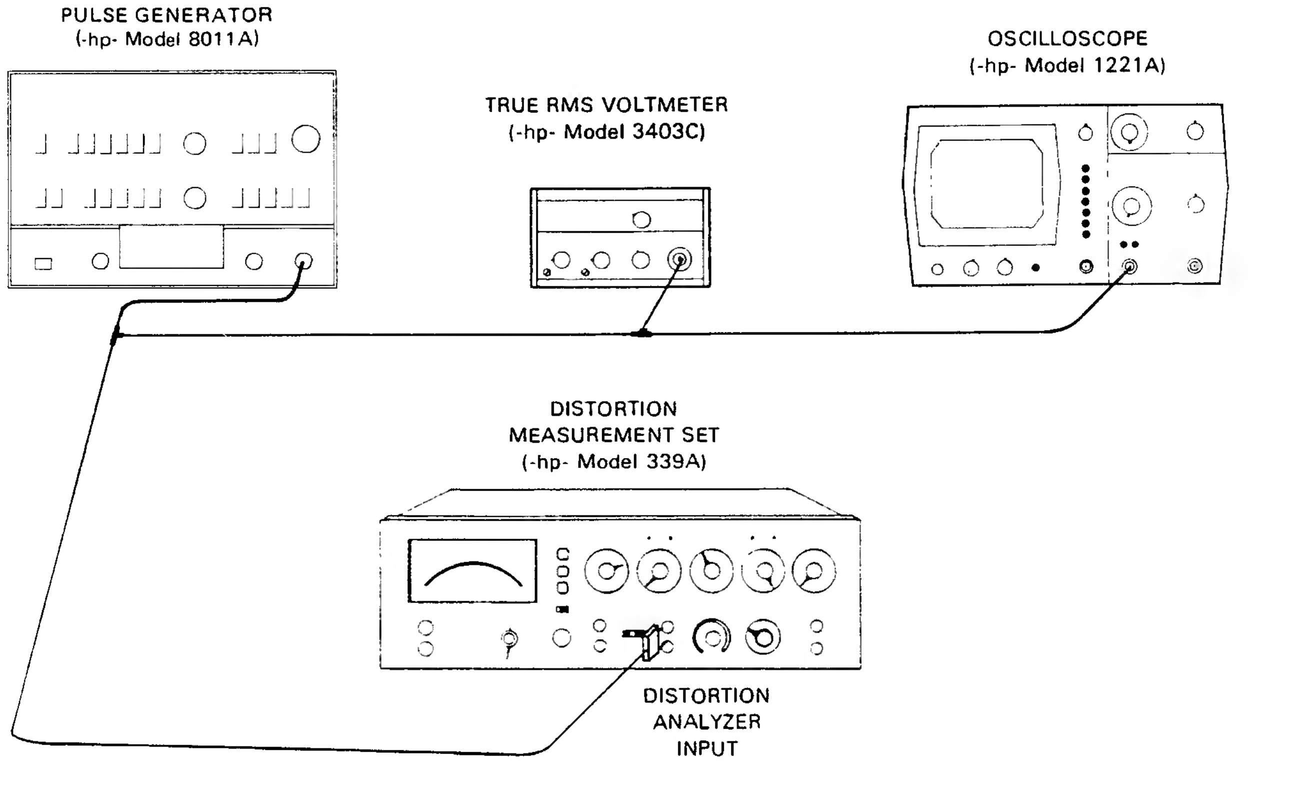


Figure 4-3. RMS Accuracy Test.

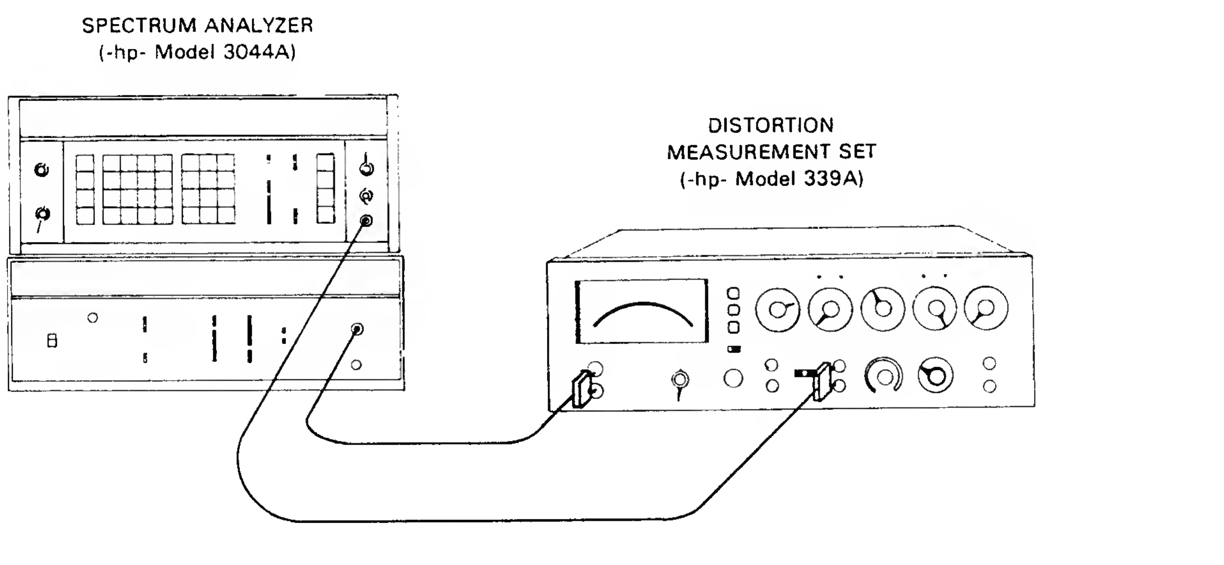


Figure 4-4. Filter Accuracy Test.

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Set the AC Calibrator controls for an output of 1 V, 1 kHz.

c. Set the True RMS Voltmeter to read AC Volts on the 1 V range.

d. Connect the equipment as shown in Figure 4-2.

e. The 339A 1 V meter indication and MONITOR output level should be within the Test Limits listed in Table 4-2.

f. Using the AC Calibrator, verify the 339A meter accuracy and MONITOR output accuracy for each input level listed in Table 4-2.

Table 4-2. Meter Tracking and MONITOR Output Accuracy Tests.

Input Level	Meter Indication	Monitor Output Level
1.0 V	.98 - 1.02	.95 - 1.05
.9 V	.88 - .92	.85 - .95
.8 V	.78 - .82	.75 - .85
.7 V	.68 - .72	.65 - .75
.6 V	.58 - .62	.55 - .65
.5 V	.48 - .52	.45 - .55
.4 V	.38 - .42	.35 - .45
.3 V	.28 - .32	.25 - .35
.2 V	.18 - .22	.15 - .25
.1 V	.08 - .12	.05 - .15

4-13. RMS Accuracy (crest factor) Test.

Equipment Required:

Pulse Generator (-hp- Model 8011A)
True RMS Voltmeter (-hp- Model 3403C)
Oscilloscope (-hp- Model 1221A)

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE .... 3 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Connect the equipment as shown in Figure 4-3.

c. Adjust the pulse generator for a 10 V peak-to-peak positive pulse with a repetition rate of 1 kHz (as observed on the oscilloscope).

d. Adjust the Pulse Geneator symmetry until the true RMS voltmeter indicates 3.00 V rms.

NOTE

The pulse generator amplitude and symmetry controls may interact. Repeat adjustments as necessary to obtain a true rms meter indication of 3 V and an oscilloscope presentation of 10 V peak-to-peak.

e. The 339A meter indication must be 3 volts ± .06 volts.

f. Change the Pulse Generator repetition rate to 100 Hz. Readjust the amplitude and symmetry as necessary to obtain a true RMS meter indication of 3 V and a 10 V peak-to-peak oscilloscope presentation.

g. The 339A meter indication must be 3 V ± .06 volts.

h. Change the Pulse Generator repetition rate to 10 kHz. Readjust the amplitude and symmetry as necessary to obtain a True RMS meter reading of 3 V and a 10 V peak-to-peak oscilloscope presentation.

i. The 339A meter indication must be 3 V ± .12 volts.

4-14. Filter Accuracy Test.

Equipment Required:

Spectrum Analyzer (-hp- Model 3044A)

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Connect the equipment as shown in Figure 4-4.

c. Set theSynthesizer (3330B) output frequency to 400 Hz and adjust the output level for a full-scale meter reading on the 339A.

d. Set the Spectrum Analyzer (3571A) controls for an input impedance of 1 MΩ, an input range of +10 dB V, a bandwidth of 3 Hz and a relative display reference.

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Set the AC Calibrator controls for an output of 1 V, 1 kHz.

c. Set the True RMS Voltmeter to read AC Volts on the 1 V range.

d. Connect the equipment as shown in Figure 4-2.

e. The 339A 1 V meter indication and MONITOR output level should be within the Test Limits listed in Table 4-2.

f. Using the AC Calibrator, verify the 339A meter accuracy and MONITOR output accuracy for each input level listed in Table 4-2.

Table 4-2. Meter Tracking and MONITOR Output Accuracy Tests.

Input Level	Meter Indication	Monitor Output Level
1.0 V	.98 - 1.02	.95 - 1.05
.9 V	.88 - .92	.85 - .95
.8 V	.78 - .82	.75 - .85
.7 V	.68 - .72	.65 - .75
.6 V	.58 - .62	.55 - .65
.5 V	.48 - .52	.45 - .55
.4 V	.38 - .42	.35 - .45
.3 V	.28 - .32	.25 - .35
.2 V	.18 - .22	.15 - .25
.1 V	.08 - .12	.05 - .15

4-13. RMS Accuracy (crest factor) Test.

Equipment Required:

Pulse Generator (-hp- Model 8011A)
True RMS Voltmeter (-hp- Model 3403C)
Oscilloscope (-hp- Model 1221A)

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE .... 3 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Connect the equipment as shown in Figure 4-3.

c. Adjust the pulse generator for a 10 V peak-to-peak positive pulse with a repetition rate of 1 kHz (as observed on the oscilloscope).

d. Adjust the Pulse Geneator symmetry until the true RMS voltmeter indicates 3.00 V rms.

NOTE

The pulse generator amplitude and symmetry controls may interact. Repeat adjustments as necessary to obtain a true rms meter indication of 3 V and an oscilloscope presentation of 10 V peak-to-peak.

e. The 339A meter indication must be 3 volts ± .06 volts.

f. Change the Pulse Generator repetition rate to 100 Hz. Readjust the amplitude and symmetry as necessary to obtain a true RMS meter indication of 3 V and a 10 V peak-to-peak oscilloscope presentation.

g. The 339A meter indication must be 3 V ± .06 volts.

h. Change the Pulse Generator repetition rate to 10 kHz. Readjust the amplitude and symmetry as necessary to obtain a True RMS meter reading of 3 V and a 10 V peak-to-peak oscilloscope presentation.

i. The 339A meter indication must be 3 V ± .12 volts.

4-14. Filter Accuracy Test.

Equipment Required:

Spectrum Analyzer (-hp- Model 3044A)

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... VU
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Connect the equipment as shown in Figure 4-4.

c. Set theSynthesizer (3330B) output frequency to 400 Hz and adjust the output level for a full-scale meter reading on the 339A.

d. Set the Spectrum Analyzer (3571A) controls for an input impedance of 1 MΩ , an input range of +10dB V, a bandwidth of 3 Hz and a relative display reference.

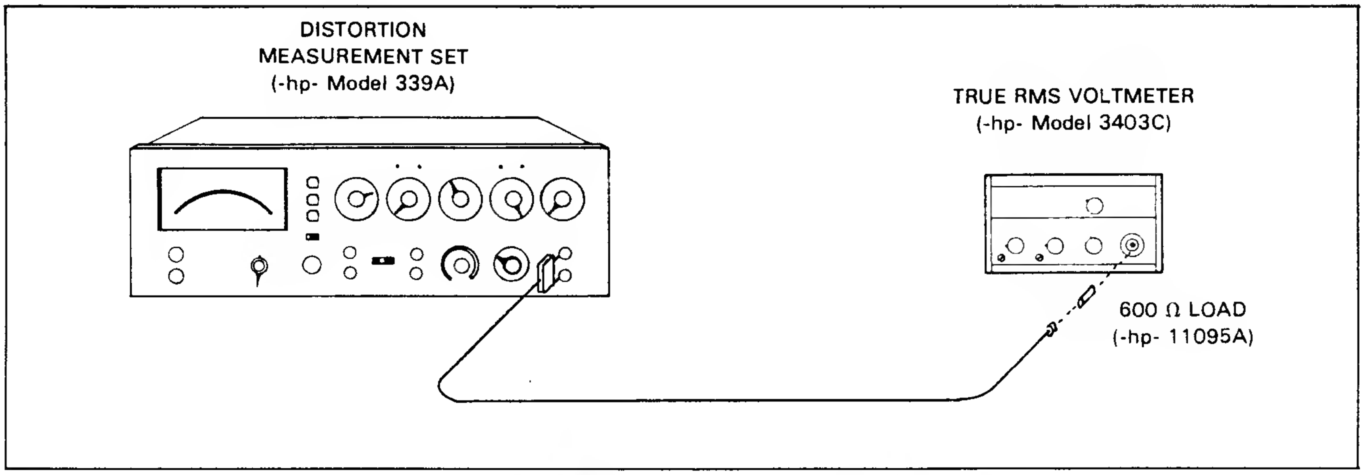


Figure 4-6. Oscillator Output Impedance Test.

FREQUENCY VERNIER .... CAL
OSCILLATOR .... 3 V

b. Connect the equipment as shown in Figure 4-6 (without the 600 ohm load).

c. Adjust the True RMS Voltmeter controls to measure AC volts on the 10 V range.

d. Adjust the 339A LEVEL vernier control to obtain a reading of 6.00 V on the True RMS voltmeter.

e. Disconnect the cable from the True RMS Voltmeter and install the 600 ohm load as shown in Figure 4-6.

f. The True RMS Voltmeter reading must be between 2.927 and 3.077 V rms.

4-18. Oscillator Frequency Accuracy Test.

Equipment Required:

Frequency Counter (-hp- Model 5300A Mainframe, 5302A Frequency Module)
600 ohm Resistive Load (-hp- 11095A)

a. Set the 339A controls as follows:

FREQUENCY .... 10 Hz (1.0 x 10)
FREQUENCY VERNIER .... CAL
OSCILLATOR LEVEL .... 3 V

Table 4-3. Oscillator Output Limits (Flatness Test).

Output Frequency	Output Level
10 Hz	2.930 - 3.070
20 Hz	2.965 - 3.035
100 Hz	2.965 - 3.035
10 kHz	2.965 - 3.035
20 kHz	2.965 - 3.035
110 kHz	2.930 - 3.070

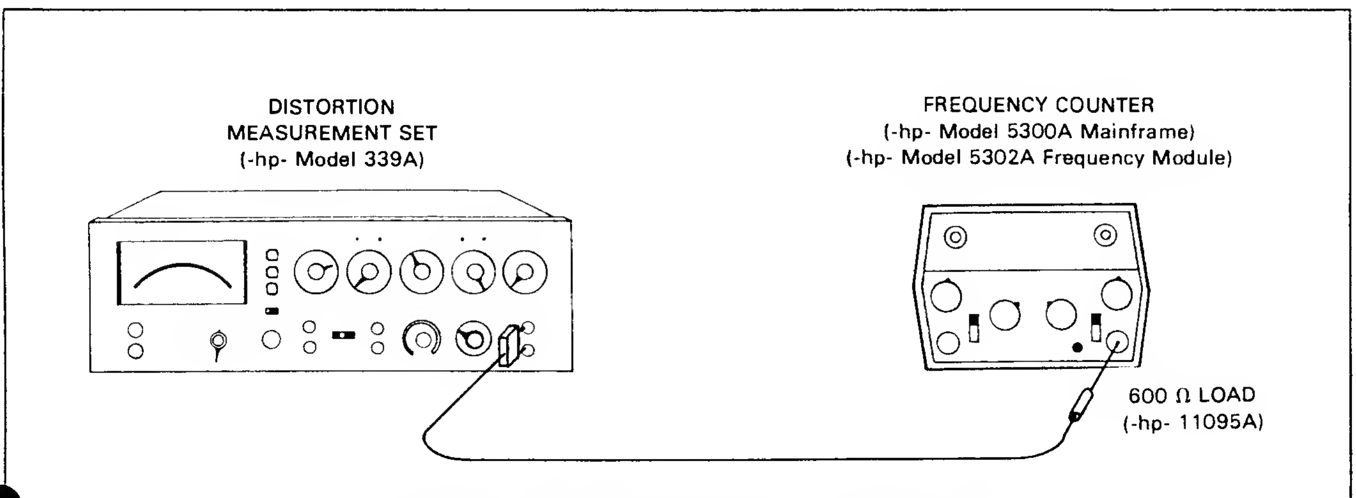


Figure 4-7. Oscillator Frequency Accuracy Test.

Table 4-4. Oscillator Frequency Accuracy Test.

Frequency	339A Frequency Range Setting	Frequency Counter Indication (Period)
10 Hz	X 10	102.04 mSec. - 98.04 mSec.
20 Hz		51.020 mSec. - 49.019 mSec.
50 Hz		20.408 mSec. - 19.608 mSec.
100 Hz		10.204 mSec. - 9.803 mSec.
100 Hz	X 100	10.204 mSec. - 9.803 mSec.
200 Hz		5.1020 mSec. - 4.9019 mSec.
500 Hz		2.0408 mSec. - 1.9608 mSec.
1 kHz		1.0204 mSec. - .9803 mSec.
[illegible] kHz	X 1K	1020.4 µSec. - 980.3 µSec.
[illegible] kHz		927.64 µSec. - 891.26 µSec.
1.2 kHz		850.34 µSec. - 816.99 µSec.
1.3 kHz		784.93 µSec. - 754.14 µSec.
1.4 kHz		728.86 µSec. - 700.28 µSec.
1.5 kHz		680.27 µSec. - 653.59 µSec.
1.6 kHz		637.75 µSec. - 612.74 µSec.
1.7 kHz		600.24 µSec. - 576.70 µSec.
1.8 kHz		566.89 µSec. - 544.66 µSec.
1.9 kHz		537.05 µSec. - 515.99 µSec.
2.0 kHz		510.20 µSec. - 490.19 µSec.
3.0 kHz		340.13 µSec. - 326.79 µSec.
4.0 kHz		255.10 µSec. - 245.09 µSec.
5.0 kHz		204.08 µSec. - 196.08 µSec.
6.0 kHz		170.06 µSec. - 163.39 µSec.
7.0 kHz		145.77 µSec. - 140.05 µSec.
8.0 kHz		127.55 µSec. - 122.54 µSec.
9.0 kHz		113.37 µSec. - 108.93 µSec.
10.0 kHz		102.04 µSec. - 98.039 µSec.
10 kHz	X 10 K	102.04 µSec. - 98.039 µSec.
20 kHz		51.020 µSec. - 49.019 µSec.
50 kHz		20.408 µSec. - 19.608 µSec.
[illegible]0 kHz		10.204 µSec. - 9.8039 µSec.
[illegible]9 kHz		9.3615 µSec. - 8.9944 µSec.

b. Connect the equipment as shown in Figure 4-7.

c. Adjust the Frequency Counter controls to measure period.

d. The 339A 10 Hz frequency should be within the limits listed in Table 4-4.

e. Verify the 339A Oscillator Frequency Accuracy for each frequency listed in Table 4-4.

4-19. Oscillator Total Harmonic Distortion Test.

Equipment Required:

Spectrum Analyzer (-hp- Model 3044A)
Tuneable Notch Filter (-hp- Model 339A)
600 ohm Resistive Load (-hp- 11095A)

a. Set the 339A controls as follows:

FUNCTION .... OSCillator LEVEL
FREQUENCY .... 10 Hz (1.0 x 10)
FREQUENCY VERNIER .... CAL
OSCILLATOR LEVEL .... 3 V

b. Connect the equipment as shown in Figure 4-8.

c. Adjust the 339A OSCILLATOR LEVEL vernier for an output level of 3 V rms as indicated on the 339A meter.

d. Set the Tuneable Notch Filter (339A) Frequency to 10 Hz and set the Function to Input Level. Adjust the Input Range control as necessary to obtain an on-scale meter indication as near full-scale as possible.

e. Set the Spectrum Analyzer (3571A) controls for an input impedance of 1 MΩ, an input range of -10 dB V, a bandwidth of 3 Hz, and a relative display reference.

f. Tune the Spectrum Analyzer to the exact frequency of the 339A under test by varying the Synthesizer (3330B) frequency until the Spectrum Analyzer indicates maximum level. Enter this frequency as both the output frequency and step frequency of the Synthesizer.

g. Reference the Spectrum Analyzer to the amplitude of the 339A fundamental frequency by pressing the Enter Offset button. (Observe a Spectrum Analyzer display of 00.00 dB.)

h. Adjust the Tuneable Notch Filter controls as necessary to make a distortion measurement. (The purpose of this step is to null the fundamental frequency of the 339A Oscillator output. This puts the distortion products within the dynamic range of the Spectrum Analyzer.)

i. Step the Synthesizer frequency to the second harmonic frequency of the 339A output.

j. The amplitude of the second harmonic frequency, relative to the fundamental frequency is determined by adding the Spectrum Analyzer display reading and the range setting of the Notch Filter. (As an example: If the Notch Filter distortion range control is set to -80 dB and the Spectrum Analyzer display indicates -23 dB the amplitude of the second harmonic is -103 dB, relative to the fundamental.) Record the amplitude reading of the second harmonic.

k. Step the Synthesizer frequency to the frequency of the third harmonic.

l. Determine the relative amplitude of the third harmonic by adding the Spectrum Analyzer display reading and the range setting of the Notch Filter. Record the amplitude reading of the third harmonic.

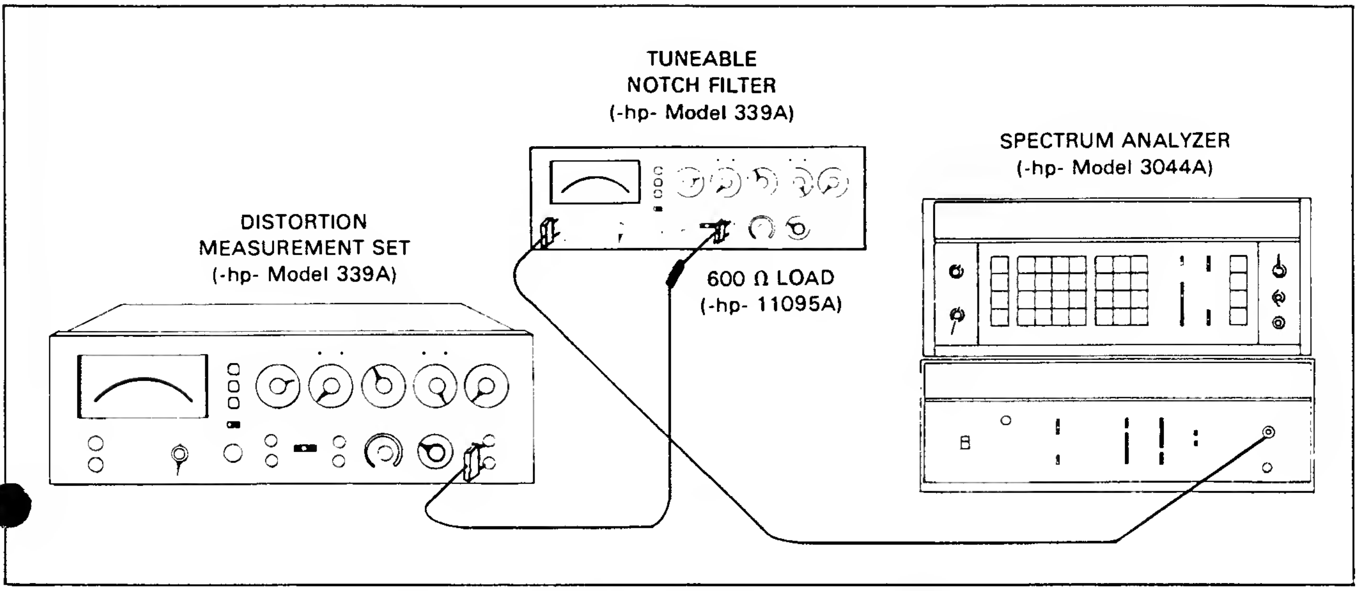


Figure 4-8. Oscillator Total Harmonic Distortion Test.

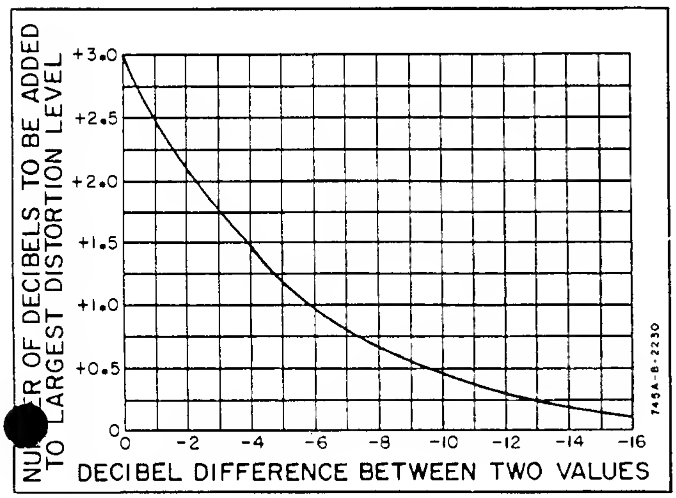


Figure 4-9. Logarithmic Addition of Harmonic Components.

Table 4-5. Oscillator Total Harmonic Distortion Test.

339A Frequency	THD Specification
10 Hz	> -95 dB
100 Hz	> -95 dB
1 kHz	> -95 dB
10 kHz	> -95 dB
20 kHz	> -95 dB
30 kHz	> -85 dB
50 kHz	> -80 dB
109 kHz	> -70 dB

m. Calculate the Total Harmonic Distortion using the graph shown in Figure 4-9. As an example: If the amplitude of the second harmonic is − 110 dB and the third harmonic amplitude is − 114 dB the dB difference between the two is − 4 dB. Locate this number on the horizontal axis of the graph. The − 4 line intersects the curve at approximately the + 1.5 level on the vertical axis. The total harmonic distortion is therefore the amplitude of the largest harmonic (2nd harmonic) plus the number determined on the vertical axis (− 110 dB + 1.5 dB = − 108.5 dB).

n. The 339A should meet the 10 Hz THD specification listed in Table 4-5.

o. Repeat Steps f through m for each freqeuncy listed in Table 4-5.

NOTE

It may be necessary to increase the Bandwidth of the Spectrum Analyzer at higher frequencies. Adjust as necessary to maintain a stable reading.

4-20. DISTORTION ANALYZER PERFORMANCE TESTS.

4-21. The Voltmeter Performance Tests, at the beginning of this section, should be performed and the Voltmeter accuracy verified before proceeding with the Distortion Analyzer Tests.

4-22. Fundamental Rejection and Induced Distortion Test.

4-23. The following test requires an exceptionally low

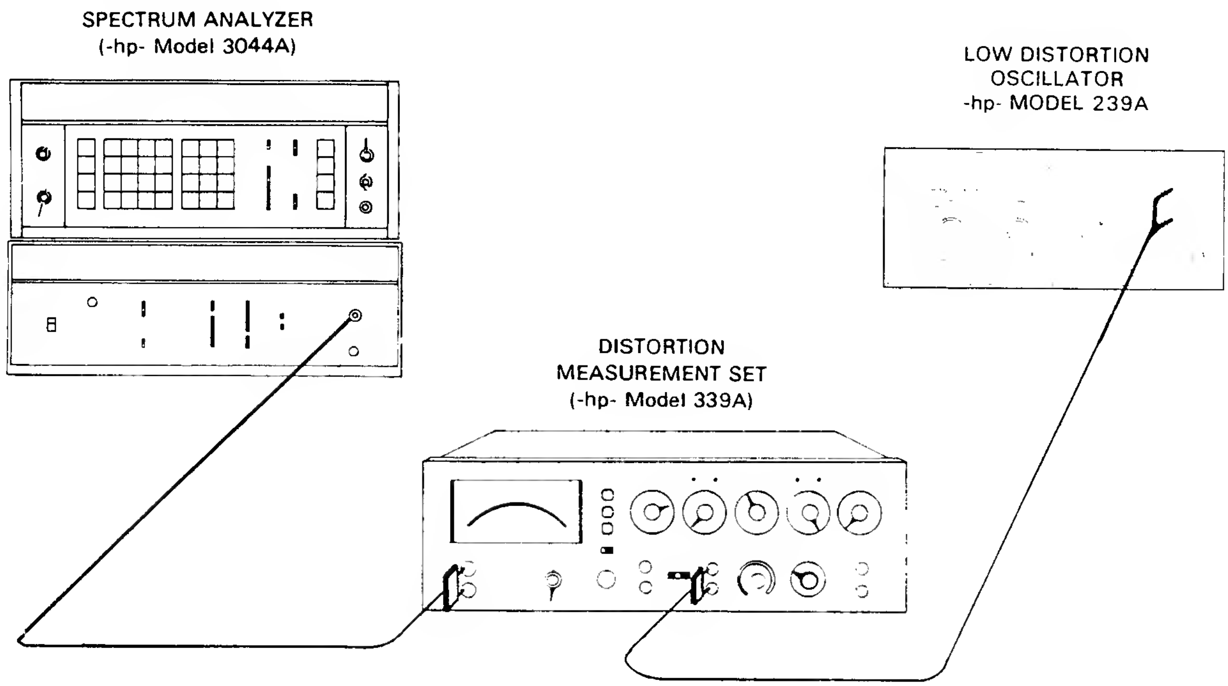


Figure 4-10. Fundamental Rejection and Induced Distortion Test.

distortion signal source. In most cases the Model 339A being used as a source will be sufficient. However, if the instrument under test does not meet the Induced Distortion specifications listed in Table 4-6, it must be determined whether the distortion is due to the signal source or the analyzer under test. In some cases this may be accomplished by exchanging the signal source with another. If this is not practical, low-pass filters may be constructed to enhance the signal purity of the source.

a. Set the 339A controls as follows:

FUNCTION	INPUT LEVEL
FILTERS	OFF (out)
METER RESPONSE	NORMAL
INPUT RANGE	3 V
INPUT/GND SELECT .... (center position)	DIS. AN./⊥
FREQUENCY	10 Hz (1.0 x 10)

b. Connect the equipment as shown in Figure 4-10.

c. Set the Low Distortion Oscillator for an output frequency of 10 Hz. Adjust the output level for a full-scale (0 dB) meter indication on the 339A under test.

d. Adjust the frequency of the Synthesizer (3330B) for a maximum level indication on the Spectrum Analyzer (3571A). Enter this frequency as both the output frequency and step frequency of the synthesizer.

NOTE

When adjusting the frequency of the Synthesizer, use frequency steps equal to 10% of the fundamental frequency being measured. This insures adequate resolution.

e. Reference the Spectrum Analyzer to this level by pressing the enter offset button. The Spectrum Analyzer should indicate 00.00 dB.

f. Set the FUNCTION switch of the 339A under test to DISTORTION.

g. Adjust the DISTORTION RANGE control for an on-scale meter indication as near full-scale as possible.

h. Determine the fundamental rejection of the 339A under test by adding the display reading of the Spectrum Analyzer and the distortion range setting of the 339A under test. (As an example: If the 339A DISTORTION RANGE control is set to -80 dB and the Spectrum Analyzer display indicates -35 dB the fundamental rejection is -115 dB.)

i. The fundamental rejection level determined in the previous step must meet or exceed the specification listed in Table 4-6.

j. Step the Synthesizer frequency to the second harmonic frequency.

Table 4-6. Fundamental Rejection and Induced Distortion Test.

Test Frequency	Fundamental Rejection Specification	Induced Distortion Specification
10 Hz 100 Hz 1 kHz 10 kHz 20 kHz	> -100 dB	> -95 dB
30 kHz	> -90 B	> -90 dB
50 kHz		> -85 dB
110 kHz		> -70 dB

k. Determine the relative amplitude of the second harmonic by adding the Spectrum Analyzer display reading and the distortion range setting of the 339A under test. Record the amplitude reading of the second harmonic.

l. Step the Synthesizer frequency to the third harmonic frequency.

m. Determine the relative amplitude of the third harmonic by adding the Spectrum Analyzer display reading and the distortion range setting of the 339A under test. Record the amplitude reading of the third harmonic.

n. Calculate the Induced Harmonic Distortion using the graph shown in Figure 4-9.

o. The induced distortion measurement must meet or exceed the specification listed in Table 4-6.

p. Set the FUNCTION switch of the 339A under test to INPUT LEVEL.

q. Repeat Steps c through p for each frequency listed in Table 4-6.

4-24. Distortion Measurement Accuracy Test.

Equipment Required:

Spectrum Analyzer (-hp- Model 3044A)
Low Distortion Oscillator (-hp- Model 339A)
600 Ω 1% Metal Film Resistor (-hp- Part No. 0698-5405)
60 kΩ 1% Metal Film Resistor (-hp- Part No. 0698-5973)

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
DISTORTION RANGE...........-80 dB
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN. ⊥ (center position)
FREQUENCY .... 10 kHz (1.0 x 10 K)

b. Connect the equipment as shown in Figure 4-11.

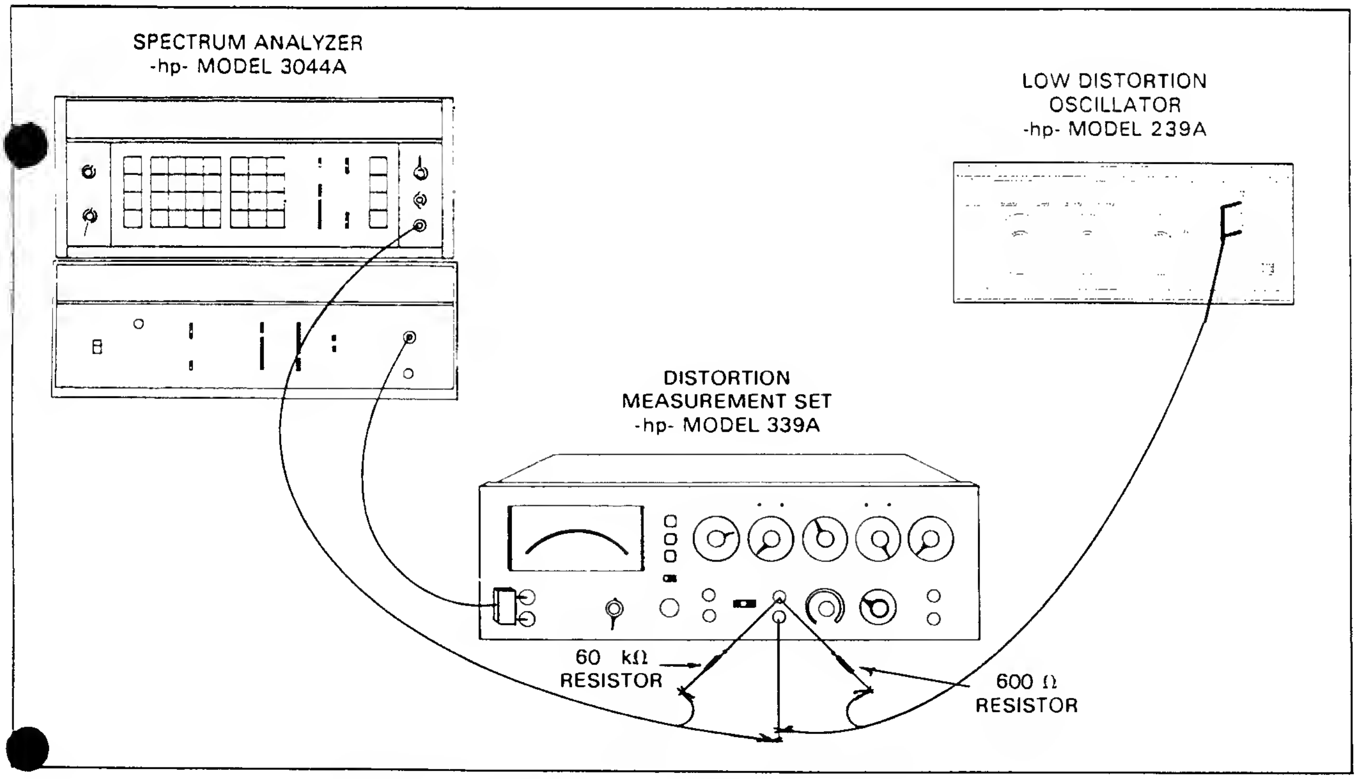


Figure 4-11. Distortion Measurement Accuracy Test.

Table 4-7. Distortion Measurement Accuracy Test.

Distortion Frequency	Accuracy Limits
10 Hz	+1.0 dB, -2.0 dB
20 Hz	±1.0 dB
100 Hz	±1.0 dB
20 kHz	±1.0 dB
50 kHz	+1.0 dB, -2.0 dB
100 kHz	+1.5 dB, -4.0 dB
330 kHz	+1.5 dB, -4.0 dB

c. Adjust the Synthesizer (3330B) controls for an output frequency of 1 kHz and an output amplitude of -10 dBm.

d. Set the Low Distortion Oscillator for an output frequency of 10 kHz. Adjust the output level for a meter indication of 1 V on the 339A under test.

e. Set the FUNCTION switch of the 339A under test to DISTORTION.

f. Adjust the Synthesizer amplitude as necessary to obtain a distortion reading of -80 dB on the 339A under test (full-scale meter indication).

g. Set the Spectrum Analyzer (3571A) to a 3 Hz bandwidth, an input range of +10 dB V, an input impedance of 1 M Ω , and a relative display reference. Reference the Spectrum Analyzer to the 339A measurement by pressing the Enter Offset button.

h. Set the Synthesizer to each frequency listed in Table 4-7, and verify that the Spectrum Analyzer reading is within the limits listed.

4-25. Residual Noise Test.

Equipment Required:

1 k Ω shielded load (Refer to Figure 4-12.)

a. Set the 339A controls as follows:

FUNCTION .... DISTORTION
FILTERS ....80 kHz ON (in)
DISTORTION RANGE...........-80 dB
INPUT RANGE .... 1 V
FREQUENCY .... 20 kHz (2.0 x 10 K)
INPUT, GND SELECT ..... DIS. AN. ⊥
(center position)

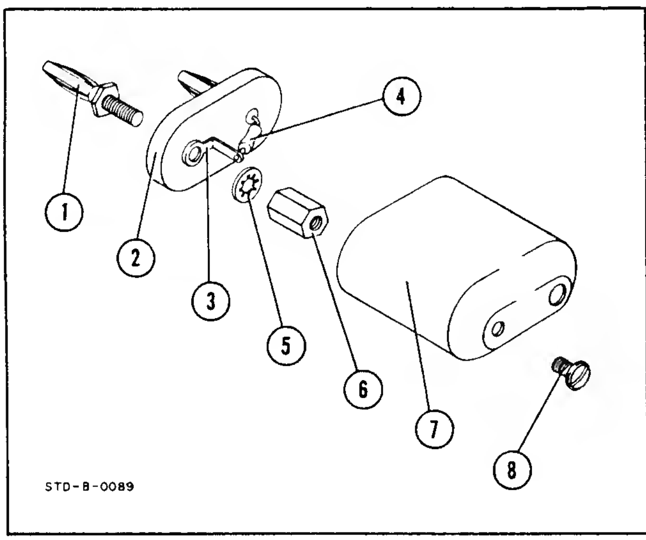
b. Connect the 1 kΩ shielded load to the DISTORTION ANALYZER input terminals. (See Figure 4-12 for construction details of 1 k Ω load.)

c. The 339A measurement indication must be below -92 dB.

4-26. Input Impedance Test.

Equipment Required:

Spectrum Analyzer (-hp- Model 3044A)
100 k Ω 0.1% Metal Film Resistor (-hp- Part No. 0698-4158)



No.	Description	-hp- Part No.
1	Connector, male	1251-0174
2	Connector, male w/insulator	1251-0175
3	Lug, terminal 90°	0360-0042
4	Resistor, 1 kΩ, 1/8 W, 1%, metal flm	0757-0280
5	Washer, int. lock	2190-0007
6	Spacer, 6-32 threaded	0380-0058
7	Shield	1251-1073
8	Screw, pan head, 6-32 x 1/4 in.	2360-0113

Figure 4-12. Shielded Load Assembly.

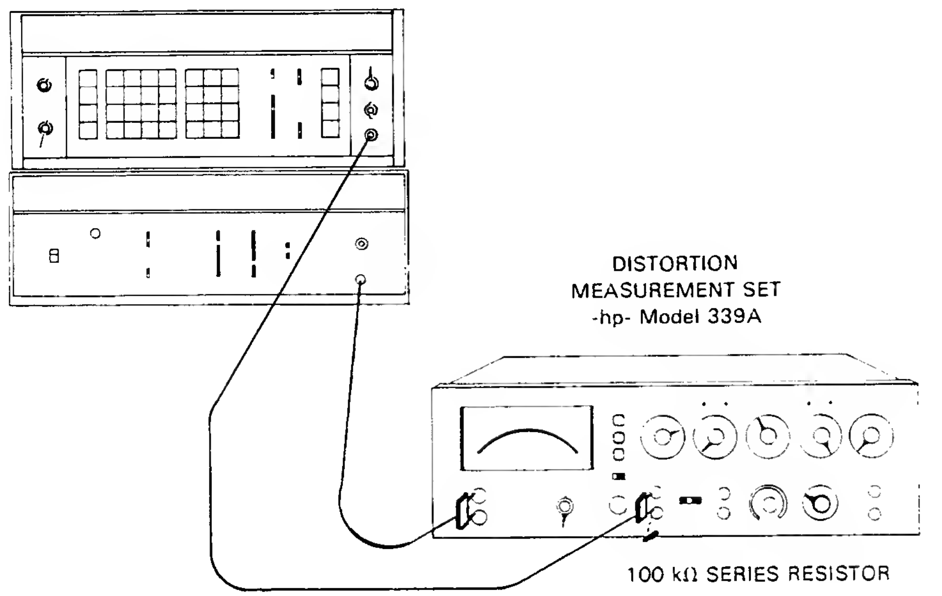


Figure 4-13. Input Impedance Test.

a. Set the 339A controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)

b. Connect the equipment as shown in Figure 4-13.

c. Set the Synthesizer (3330B) for an output frequency of 1 kHz and adjust the amplitude as necessary to obtain a meter reading of 0 dB on the 339A.

d. Set the Spectrum Analyzer (3571A) reference by pressing the Enter Offset button. Observe a display reading of 00.00 dB.

e. Disconnect the cable from the 339A and insert the 100 kΩ resistor in series with the input. The Spectrum Analyzer must indicate -6.02 dB ± .05 dB.

f. Change the Synthesizer frequency to 17.000 kHz. The Spectrum Analyzer reading must be less than -9.00 dB indicating an input capacitance of less than 100 pF.

PERFORMANCE TEST RECORD

Hewlett-Packard Model 339A

Distortion Measurement Set

Serial No. ____________

Tests Performed By: ____________

Date: ____________

VOLTMETER PERFORMANCE

Full-Scale Accuracy and Frequency Response Test:

Input Level	339A Input Range	339A 10 Hz Reading	339A 110 KHz Reading	Test Limits	339A 20 Hz Reading	339A 100 Hz Reading	339A 1 kHz Reading	339A 10 kHz Reading	339A 20 kHz Reading	Test Limits
.001 V	.001 V			.00096 - .00104						.00098 - .00102
.003 V	.003 V			.00288 - .00312						.00294 - .00306
.01 V	.01 V			.0096 - .0104						.0098 - .0102
.03 V	.03 V			.0288 - .0312						.0294 - .0306
.1 V	.1 V			.096 - .104						.098 - .102
.3 V	.3 V			.288 - .312						.294 - .306
1 V	1 V			.96 - 1.04						.98 - 1.02
3 V	3 V			2.88 - 3.12						2.94 - 3.06
10 V	10 V			9.6 - 10.4						9.8 - 10.2
30 V	30 V			28.8 - 31.2						29.4 - 30.6
100 V	100 V			96 - 104						98 - 102
300 V	300 V			288 - 312						294 - 306

Meter Tracking and Monitor Output Accuracy Test:

Input Level	339A Meter Reading	Test Limits	Monitor Output Level	Test Limits
1.0 V		.98 - 1.02		.95 - 1.05
.9 V		.88 - .92		.85 - .95
.8 V		.78 - .82		.75 - .85
.7 V		.68 - .72		.65 - .75
.6 V		.58 - .62		.55 - .65
.5 V		.48 - .52		.45 - .55
.4 V		.38 - .42		.35 - .45
.3 V		.28 - .32		.25 - .35
.2 V		.18 - .22		.15 - .25
.1 V		.08 - .12		.05 - .15

PERFORMANCE TEST RECORD (Cont'd)

RMS Accuracy (crest factor) Test:

RMS Input Level	Repetition Rate	339A Meter Reading	Test Limits
	100 Hz	________	2.94 - 3.06
3 V	1 kHz	________	2.94 - 3.06
	10 kHz	________	2.88 - 3.12

Filter Accuracy Test:

339A Filter	-3 dB Frequency	Test Limits
400 Hz	________	360 Hz - 435 Hz
30 kHz	________	27 kHz -32.6 kHz
80 kHz	________	72.1 kHz - 87 kHz

OSCILLATOR PERFORMANCE

Output Level and Flatness Test:

339A Output Frequency	Output Level	Test Limits
10 Hz	________	2.930 - 3.070
20 Hz	________	2.965 - 3.035
100 Hz	________	2.965 - 3.035
10 kHz	________	2.965 - 3.035
20 kHz	________	2.965 - 3.035
110 kHz	________	2.930 - 3.070

Maximum Output Level into 600 Ω = ________ (> 3 V rms)

Output Impedance Test:

With an unloaded output level of 6.00 V rms, the output level into a 600 Ω load = ________
(test limit 2.927 – 3.077 V rms).

Oscillator Frequency Accuracy Test:

339A Output Frequency	339A Frequency Range Setting	Frequency Counter Indication (Period)	Test Limits
10 Hz		________	98.04 - 102.04 msec.
20 Hz	X 10	________	49.019 - 51.020 msec.
50 Hz		________	19.608 - 20.408 msec.
100 Hz		________	9.803 - 10.204 msec.
100 Hz		________	9.803 - 10.204 msec.
200 Hz	X 100	________	4.9019 - 5.1020 msec.
500 Hz		________	1.9608 - 2.0408 msec.
1 kHz		________	.9803 - 1.0204 msec.

PERFORMANCE TEST RECORD (Cont'd)

Oscillator Frequency Accuracy Test (Cont'd):

339A Output Frequency	339A Frequency Range Setting	Frequency Counter Indication (Period)	Test Limits
1.0 kHz	X 1K	______	980.3 - 1020.4 μsec.
1.1 kHz		______	891.26 - 927.64 μsec.
1.2 kHz		______	816.99 - 850.34 μsec.
1.3 kHz		______	754.14 - 784.93 μsec.
1.4 kHz		______	700.28 - 728.86 μsec.
1.5 kHz		______	653.59 - 680.27 μsec.
1.6 kHz		______	612.74 - 637.75 μsec.
1.7 kHz		______	576.70 - 600.24 μsec.
1.8 kHz		______	544.66 - 566.89 μsec.
1.9 kHz		______	515.99 - 537.05 μsec.
2.0 kHz		______	490.19 - 510.20 μsec.
3.0 kHz		______	326.79 - 340.13 μsec.
4.0 kHz		______	245.09 - 255.10 μsec.
5.0 kHz		______	196.08 - 204.08 μsec.
6.0 kHz		______	163.39 - 170.06 μsec.
7.0 kHz		______	140.05 - 145.77 μsec.
8.0 kHz		______	122.54 - 127.55 μsec.
9.0 kHz		______	108.93 - 113.37 μsec.
10 kHz		______	98.039 - 102.04 μsec.
10 kHz	X 10K	______	98.039 - 102.04 μsec.
20 kHz		______	49.019 - 51.020 μsec.
50 kHz		______	19.608 - 20.408 μsec.
100 kHz		______	9.8039 - 10.204 μsec.
109 kHz		______	9.3615 - 8.9944 μsec.

Oscillator Total Harmonic Distortion Test:

339A Output Frequency	Calculated THD	Test Limit
10 Hz	______	-95 dB
100 Hz	______	
1 kHz	______	
10 kHz	______	
20 kHz	______	
30 kHz	______	-85 dB
50 kHz	______	-80 dB
109 kHz	______	-70 dB

PERFORMANCE TEST RECORD (Cont'd)

DISTORTION ANALYZER PERFORMANCE

Fundamental Rejection and Induced Distortion Test:

Test Frequency	339A Fundamental Rejection	Test Limit	339A Induced Distortion	Test Limit
10 Hz	________	-100 dB	________	-95 dB
100 Hz	________	-100 dB	________	-95 dB
1 kHz	________	-100 dB	________	-95 dB
10 kHz	________	-100 dB	________	-95 dB
20 kHz	________	-100 dB	________	-95 dB
30 kHz	________	-90 dB	________	-90 dB
50 kHz	________	-90 dB	________	-85 dB
110 kHz	________	-90 dB	________	-70 dB

Distortion Measurement Accuracy Test:

Distortion Frequency	Spectrum Analyzer Reading	Test Limit
10 Hz	________	+1.0 dB, -2.0 dB
20 Hz	________	±1.0 dB
100 Hz	________	±1.0 dB
20 kHz	________	±1.0 dB
50 kHz	________	+1.0 dB, -2.0 dB
100 kHz	________	+1.5 dB, -4.0 dB
330 kHz	________	+1.5 dB, -4.0 dB

Residual Noise Test:

Residual Noise with 1 kΩ input load and 80 kHz Filter = ________ .Test Limit; below -92 dB.

Input Impedance Test:

Spectrum Analyzer indication for 100 kΩ resistance in series with 339A input, freqeuncy -1 kHz = ________. Test Limit -5.97 to -6.07 dB.

Spectrum Analyzer indication for frequency of 17 kHz = ________ . Test Limit -6.02 to -9.00 dB.

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains complete adjustment procedures for the Model 339A Distortion Measurement Set. After the instrument has been adjusted according to the procedures given in this section, it should meet the accuracy specifications listed in Table 1-1.

5-3. EQUIPMENT REQUIRED.

5-4. The test equipment required to perform the adjustments is listed at the beginning of each adjustment procedure and in the Recommended Test Equipment Table in Section I. If the recommended equipment is not available, substitute equipment which meets the critical specifications listed in the table may be used.

5-5. ADJUSTMENT LOCATIONS.

5-6. The location of all adjustments is shown in Figure 5-3 at the back of this section. The function of each adjustment is listed in Table 5-2.

5-7. FACTORY SELECTED COMPONENTS.

5-8. Certain components in the Model 339A are individually selected to compensate for varying circuit parameters. These components are noted on the schematics and in the material list by an asterisk (*). The value listed in the material list and on the schematic is the typical value of the selected component. The function of the factory selected components and their value ranges are listed in Table 5-1.

5-9. VOLTMETER ADJUSTMENTS.

5-10. Mechanical Meter Zero.

5-11. The mechanical meter-zero should be checked and adjusted, if necessary, before proceeding with the calibration procedures. The meter-zero is checked when the instrument is at its operating temperature and the power is off. The meter zero is correctly set when the pointer rests directly over the zero mark on the meter scale. To adjust the meter-zero, proceed as follows:

a. Turn the instrument on and allow it to "warmup" for at least 20 minutes.

b. Turn the instrument off and allow approximately 30 seconds for all capacitors to discharge.

c. Rotate the zero adjustment screw clockwise until the pointer is left of zero and moving up-scale.

d. Continue rotating the screw clockwise until the pointer is exactly over the zero calibration mark.

e. Rotate the adjustment screw slightly counter-clockwise to relieve tension on the pointer suspension. If the pointer moves off zero, repeat Steps c through e, but make the counter-clockwise rotation less.

5-12. Gain Adjustments.

Equipment Required:

AC Calibrator (-hp- Model 745A).
Digital Voltmeter (-hp- Model 3465A).

a. Set the 339A controls as follows:

FUNCTION	INPUT LEVEL
FILTERS	OFF (out)
METER RESPONSE	VU
INPUT RANGE	3 V
INPUT/GND SELECT (center position)	DIS. AN./⊥

b. Set the AC Calibrator for an output of 3 V at 1 kHz. Connect the output of the AC Calibrator to the 339A DISTORTION ANALYZER input.

c. Adjust A2R17 (FULL SCALE ADJUST) for a meter indication of exactly 3 V.

d. Reduce the AC Calibrator output to 1 V at 1 kHz.

e. Adjust A2R37 (1/3 SCALE ADJUST) for a meter indication of exactly 1 V.

NOTE

The adjustment of A2R17 and A2R37 interact. Repeat Steps b through e until the meter indication is correct at both fullscale (3 V) and one-third scale (1 V).

f. Set the AC Calibrator for an output of 3.162 V at 1 kHz. Set the Digital Voltmeter to measure DC volts (20 volt range).

g. Connect the DVM's low input to the A2 assembly shield and the high input to A2TP2.

h. Adjust A2R36 (REFERENCE ADJUST) for a DVM reading of +3.162 V dc.

i. Reduce the AC calibrator output to 0.94 V.

j. Adjust A2R35 (LOW LIMIT ADJUST) until the INPUT RANGE low limit indicator just lights.

k. Increase the AC Calibrator output to 0.95 V. The low limit indicator should turn off. If not, repeat Steps i and j.

l. Increase the AC Calibrator output to 3.10 V. Note that both high and low INPUT RANGE indicator lights are OFF.

m. Increase the AC Calibrator output to 3.4 V. The INPUT RANGE high limit indicator should light.

CAUTION

Set the LINE switch OFF before performing the following steps to prevent damaging A2U7.

n. Set the 339A LINE switch OFF.

o. Disconnect the cable from A2J2. Place the cable in such a manner that it will not short against the chassis or components on the PC assembly.

p. Install a jumper wire between A2TP1 and A2TP8.

q. Set the DVM to measure DC volts (20 volt range). Connect the DVM's high input to A2TP9 and the low input to the A2 assembly shield.

r. Set the AC Calibrator for an output of 3 V at 1 kHz.

s. Set the 339A LINE switch ON.

t. Adjust A2R24 (AUTO SET-LEVEL FULL SCALE ADJUST) for a DVM reading of +3.162 V dc.

u. Reduce the AC Calibrator output to 1 V.

v. Adjust A2R22 (AUTO-SET LEVEL 1/3 SCALE ADJUST) for a DVM reading of +3.162 V dc.

NOTE

The adjustment of A2R22 and A2R24 interact. Repeat Steps r through v until the DVM indication at both full-scale and 1/3 scale is +3.162 V dc ±0.02 V dc.

w. While observing the DVM, set the AC Calibrator for output of 1.5, 2.0, 2.5, and 3 volts. The DVM should indicate 3.162 V dc ±0.04 V dc for each setting.

x. Set the 339A LINE switch to OFF.

y. Remove the test jumper and DVM leads. Reconnect the cable to A2J2. Return the LINE switch to ON.

5-13. OSCILLATOR ADJUSTMENTS.

5-14. Amplitude Adjustment.

Equipment Required:

Digital Voltmeter (-hp- Model 3465A).

a. Set the 339A controls as follows:

FREQUENCY .... 10 Hz (1.0 x 10)
FREQUENCY VERNIER .... CAL
OSCILLATOR LEVEL .... 3 V
(vernier fully CW)

b. Set the DVM to measure DC volts (2 volt range). Connect the DVM's high input to A1TP8 and the low input to the A1 assembly shield.

c. Adjust A1R30 (AMPLITUDE ADJUST) for a DVM reading of -0.4 V dc ±0.1 V dc.

5-15. Frequency Adjustment.

Equipment Required:

Electronic Counter (-hp- Model 5300A mainframe. Model 5302A Universal Counter Module.)

a. Set the 339A controls as follows:

FREQUENCY .... 10 kHz (1.0 x 10 K)
FREQUENCY VERNIER .... CAL
OSCILLATOR LEVEL .... 3 V
(vernier fully CW)

b. Connect the Electronic Counter input to the 339A Oscillator output.

c. Adjust A1C7 (10 kHz adjust) for a counter indication of 10 kHz ±10 Hz.

d. Set the 339A FREQUENCY controls for a frequency of 100 kHz (10.0 x 10 K).

e. Verify that the counter reads 100 kHz ±1 kHz. If not, readjust A1C7 until both the 10 kHz and 100 kHz readings are within the specified limits.

5-16. ANALYZER ADJUSTMENTS.

5-17. Notch Filter Null Adjust.

Equipment Required:

Spectrum Analzyer (-hp- Model 3044A)
Low Distortion Oscillator (-hp- Model 339A)

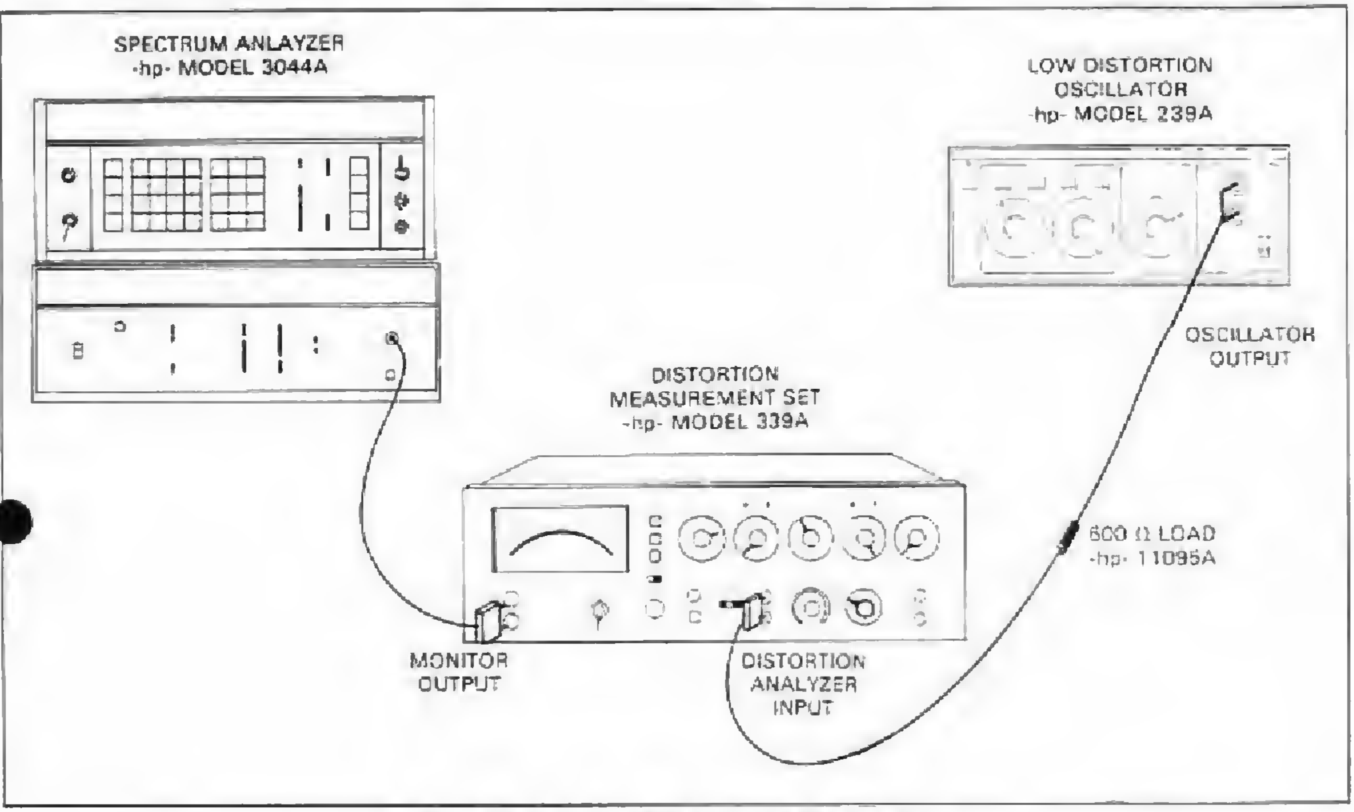


Figure 5-1. Notch Filter Null Adjustments.

a. Connect the equipment as shown in Figure 5-1.

b. Set the 339A (under test) controls as follows:

FUNCTION .... INPUT LEVEL
FILTERS .... OFF (out)
METER RESPONSE .... NORMAL
DISTORTION RANGE .... -80 dB
INPUT RANGE 3V
INPUT/GND SELECT .... DIS. AN./⊥
(center position)
FREQUENCY .... 1 kHz (1.0 x 1 K)

c. Set the controls of the 339A being used as a signal source to obtain a 1 kHz (1.0 x 1 K) signal. Adjust the output level for a meter indication of -10 dB V on the instrument under test.

d. Set the 3571A Tracking Spectrum Analyzer controls as follows:

DISPLAY REFERENCE ..... RELATIVE
DISPLAY SMOOTHING .... ON
BANDWIDTH .... 30 Hz
INPUT RANGE .... +10 (dB V)
INPUT IMPEDANCE .... 1 MΩ

e. Set the 3330B Automatic Synthesizer controls as follows:

LEVELING .... FAST
TIME/STEP .... 1000 in Sec

Enter an output frequency of 1 kHz and a step frequency of 1 Hz.

f. Step the synthesizer up or down as necessary to obtain a peak reading on the 3571A.

g. Press the 3571A Enter Offset switch and observe a display reading of 00.00 dB V.

h. Set the FUNCTION switch of the 339A under test to DISTORTION.

i. Adjust A4R16 (NOTCH FILTER NULL ADJUST) and A4R43 (NOTCH FILTER FREQUENCY ADJUST) for maximum null (greatest negative reading) as indicated by the 3571A. The null depth must be >-100 dB. Null depth is determined by adding the 339A DISTORTION RANGE setting (-80 dB) and the 3571A display reading.

NOTE

The adjustment of A4R16 and A4R43 interact. Repeat the adjustment of A4R16 and A4R43 until the maximum null is obtained.

j. Set the FUNCTION switch of the 339A under test to INPUT LEVEL.

k. Adjust the output of the 339A being used as a source for a meter indication of 0 dB V.

l. Return the 339A under test to the DISTORTION FUNCTION. The null depth must be >-100 dB. If not, readjust A4R16 and A4R43 until the null depth is >-100 dB at both input levels.

m. Set the FUNCTION switch of the 339A under test to INPUT LEVEL and the FREQUENCY controls for a frequency of 10 Hz (1.0 x 10).

n. Set the frequency of the 339A being used a signal source to 10 Hz (1.0 x 10). Adjust the output level for a meter indication of -10 dB V on the instrument under test.

o. Enter an output frequency of 10 Hz and a step frequency of 0.1 Hz into the 3330B.

p. Set the Bandwidth of the 3571A to 3 Hz.

q. Step the Synthesizer frequency up or down as necessary to obtain a peak reading on the 3571A.

r. Press the 3571A ENTER OFFSET button and observe a display reading of 00.00 dB V.

s. Enter the frequency displayed on the Synthesizer as the step frequency. Step the frequency of the Synthesizer to the second harmonic of the original frequency (one step).

t. Set the FUNCTION switch of the 339A under test to DISTORTION.

u. Adjust A4R65 (INPUT BALANCE ADJUST) for a minimum reading on the 3571A. (Greatest negative reading.)

5-18. High Frequency Adjustment.

Equipment Required:

Spectrum Analyzer (-hp- Model 3044A)
Low Distortion Oscillator (-hp- Model 339A)

600 Ω 1% Metal Film Resistor (-hp- Part No. 0698-5405)

60 kΩ 1% Metal Film Resistor (-hp- Part No. 0698-5973)

a. Connect the equipment as shown in Figure 5-2.

b. Set the 339A (under test) controls as follows:

FUNCTION .... DISTORTION
FILTERS .... OFF (out)
METER RESPONSE .... NORMAL
DISTORTION RANGE .... -80 dB
INPUT RANGE .... 1 V
INPUT/GND SELECT .... DIS. AN./⊥ (center position)
FREQUENCY .... 10 kHz (1.0 x 10 K)
OSCILLATOR LEVEL .... OFF

c. Adjust the 339A being used as a signal source to provide a 10 kHz, 1 V signal.

d. Set the 3571A Tracking Spectrum Analyzer controls as follows:

DISPLAY REFERENCE .... RELATIVE
DISPLAY SMOOTHING .... ON
BANDWIDTH .... 3 Hz
INPUT RANGE .... +10 dB V
INPUT IMPEDANCE .... 1 MΩ

e. Set the 3330B Automatic Synthesizer controls as follows:

LEVELING .... SLOW
TIME/STEP .... 3000 mSec.

Enter an output frequency of 1 kHz, an output amplitude of -40 dBm, and an amplitude step level of 1 + dBm.

f. Step the 3330B amplitude until the 339A under test indicates a distortion reading of -80 dB V.

g. Press the 3571A ENTER OFFSET button and observe a display reading of 00.00 dB.

h. Enter an output frequency of 20 kHz into the 3330B.

i. Adjust A3C18 (HIGH FREQUENCY ADJUST) for a 3571A display reading of -0.3 dB ± 0.1 dB.

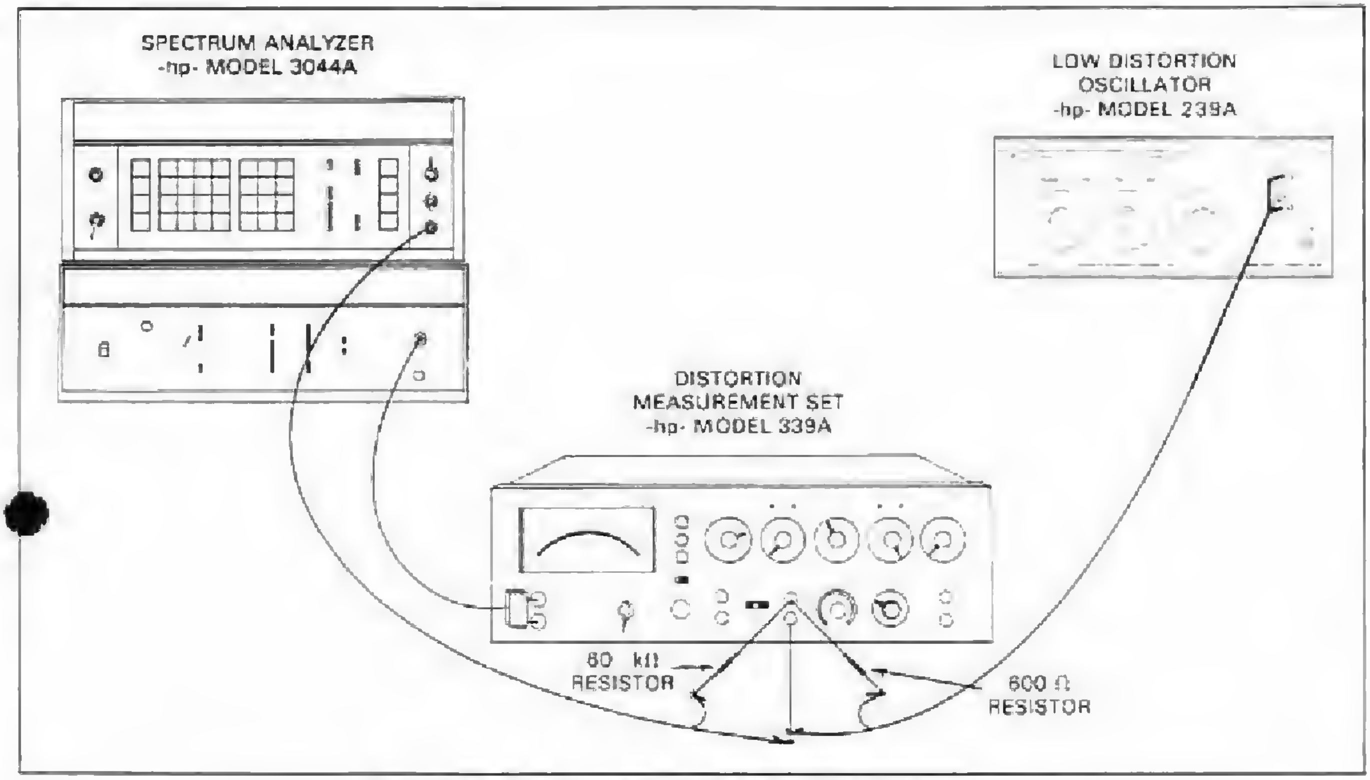


Figure 5-2. Notch Filter High Frequency Adjust.

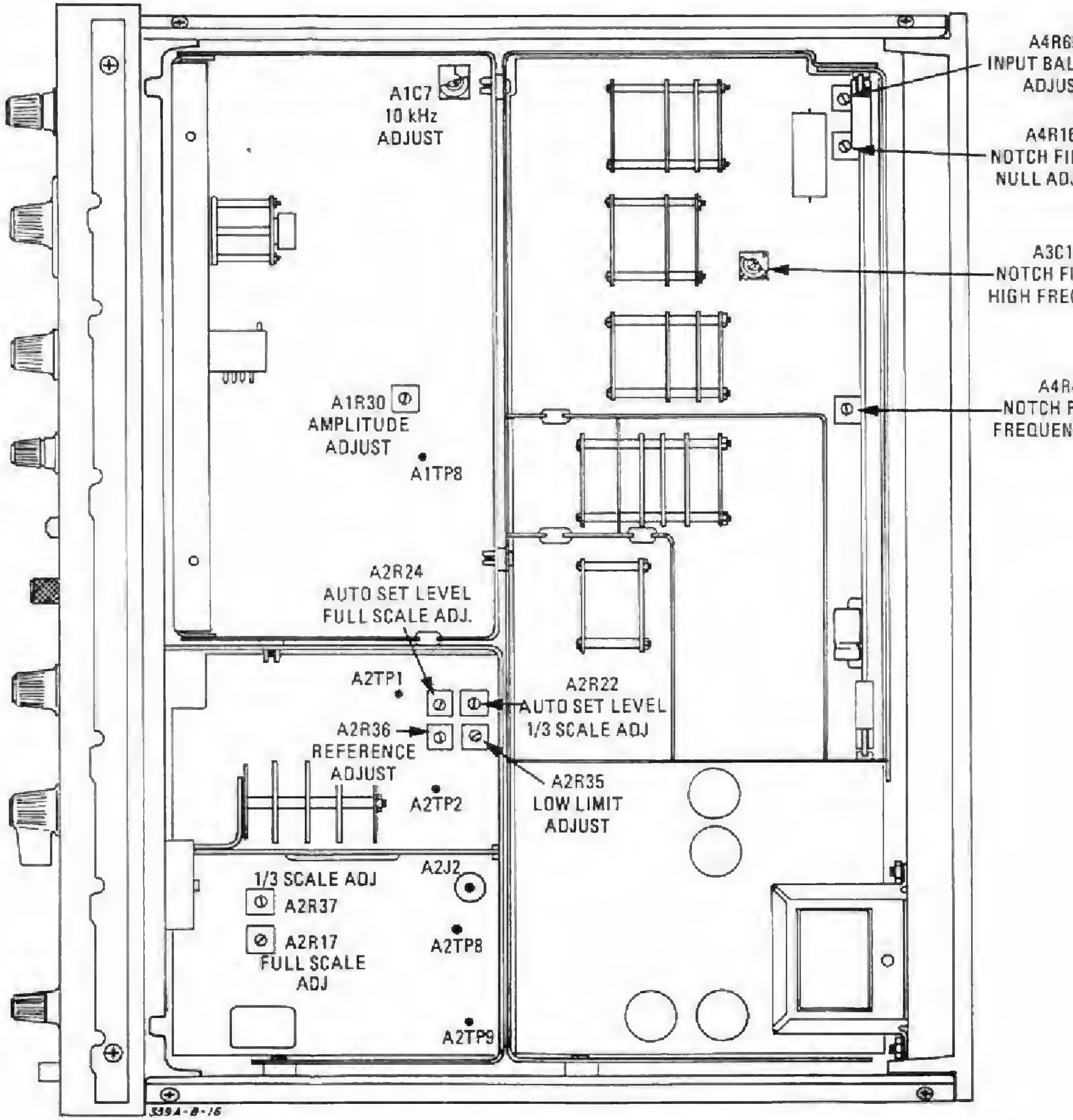


Figure 5-3. Adjustment L

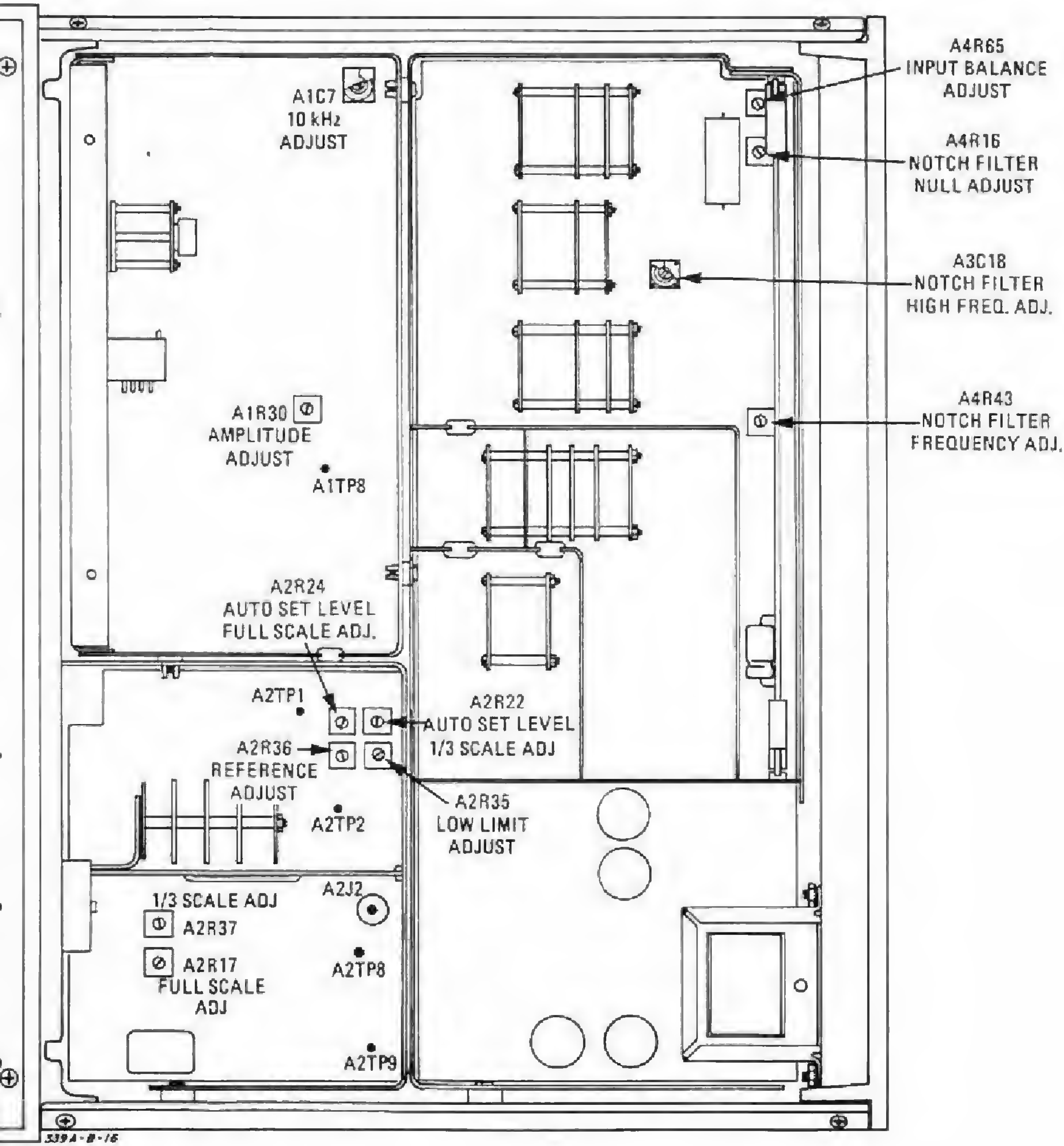


Figure 5-3. Adjustment Locations.

Table 5-1. Factory Selected Components.

Reference Designator	Range of Values	Description
A1C47	27 pF to 750 pF	Value selected for minimum second harmonic distortion at the Oscillator output for fundamental frequencies of 20 kHz and above.
A3C132	4.7 pF to 15 pF	Value selected to prevent amplifier A3U101 from oscillating.

Table 5-2. Adjustable Components.

Adjustment Name	Reference Designator	Adjustment Paragraph	Description
10 kHz ADJUST	A1C7	5-13	Adjust Oscillator frequency at 10 kHz
AMPLITUDE ADJUST	A1R30	5-13	Adjust the basic output level of the oscillator amplifier
FULL SCALE ADJUST	A2R17	5-12 (Step c)	Adjust meter amplifier for full-scale meter indication
AUTO SET-LEVEL 1/3 SCALE ADJUST	A2R22	5-12 (Step v)	Adjusts the gain of the Auto Set-Level circuit for an applied input level equal to 1/3 full-scale
AUTO SET-LEVEL FULL-SCALE ADJUST	A2R24	5-12 (Step t)	Adjusts the gain of the Auto Set-Level circuit for an applied input level equal to full-scale
LOW LIMIT ADJUST	A2R35	5-12 (Step j)	Adjust the low limit reference of the Input Level indicator circuit. Input levels below this reference will cause the low input level indicator to light
REFERENCE ADJUST	A2R36	5-12 (Step h)	Adjusts the Auto Set-Level full-scale reference voltage
1/3 SCALE ADJUST	A2R37	5-12 (Step e)	Adjusts the meter amplifier gain for proper meter indication with an applied input level equal to 1/3 of full-scale
HIGH FREQUENCY ADJUST	A3C18	5-18	Neutralizes the effects of capacitive loading of the Notch Filter.
NOTCH FILTER NULL ADJUST	A4R16	5-17	Adjusts the null depth of the Notch Filter
NOTCH FILTER FREQUENCY ADJ	A4R43	5-17	Adjusts the Notch Filter frequency to obtain maximum null depth
INPUT BALANCE ADJUST	A4R65	5-17	Adjusts the input balance to the amplitude feedback demodulator to reduce distortion at low frequencies.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See abbreviations listed in Table 6-1.)

c. Typical manufacturer of the part in a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-3.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (Field Office locations are listed at the back of the manual.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; i.e., Δ, Δ with a letter subscript, e.g., Δ_a, or Δ with a number subscript, e.g., Δ_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section VII). The

Table 6-1. Standard Abbreviations.

ABBREVIATIONS

Ag	silver
Al	aluminum
A	ampere(s)
Au	gold
C	capacitor
cer	ceramic
coef	coefficient
com	common
comp	composition
conn	connection
dep	deposited
DPDT	double-pole double-throw
DPST	double-pole single-throw
elect	electrolytic
encap	encapsulated
F	farad(s)
FET	field effect transistor
fxd	fixed
GaAs	gallium arsenide
GHz	gigahertz = 10^{+9} hertz
gd	guard(ed)
Ge	germanium
gnd	ground(ed)
H	henry(ies)
Hg	mercury

Hz	hertz (cycle(s) per second)
ID	inside diameter
impg	impregnated
incd	incandescent
ins	insulation(ed)
kΩ	kilohm(s) = 10^{+3} ohms
kHz	kilohertz = 10^{+3} hertz
L	inductor
lin	linear taper
log	logarithmic taper
mA	milliampere(s) = 10^{-3} amperes
MHz	megahertz = 10^{+6} hertz
MΩ	megohm(s) = 10^{+6} ohms
met flm	metal film
mfr	manufacturer
ms	millisecond
mtg	mounting
mV	millivolt(s) = 10^{-3} volts
μF	microfarad(s)
μs	microsecond(s)
μV	microvolt(s) = 10^{-6} volts
my	Mylar®
nA	nanoampere(s) = 10^{-9} amperes
NC	normally closed
Ne	neon
NO	normally open

NPO	negative positive zero (zero temperature coefficient)
ns	nanosecond(s) = 10^{-9} seconds
nsr	not separately replaceable
Ω	ohm(s)
obd	order by description
OD	outside diameter
p	peak
pA	picoampere(s)
pc	printed circuit
pF	picofarad(s) 10^{-12} farads
piv	peak inverse voltage
p/o	part of
pos	position(s)
poly	polystyrene
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
prec	precision (temperature coefficient, long term stability and/or tolerance)
R	resistor
Rh	rhodium
rms	root-mean-square
rot	rotary
Se	selenium
sect	section(s)
Si	silicon

sl	slide
SPDT	single-pole double-throw
SPST	single-pole single-throw
Ta	tantalum
TC	temperature coefficient
TiO_2	titanium dioxide
tog	toggle
tol	tolerance
trim	trimmer
TSTR	transistor
V	volt(s)
vacw	alternating current working voltage
var	variable
vdcw	direct current working voltage
W	watt(s)
w/	with
wiv	working inverse voltage
w/o	without
ww	wirewound
*	optimum value selected at factory, average value shown (part may be omitted)
**	no standard type number assigned (selected or special type)
®	Dupont de Nemours

DESIGNATORS

A	assembly	FL	filter	Q	transistor	TS	terminal strip
B	motor	HR	heater	QCR	transistor diode	U	microcircuit
BT	battery	IC	integrated circuit	R	resistor	V	vacuum tube, neon bulb, photocell, etc.
C	capacitor	J	jack	RT	thermistor	W	cable
CR	diode	K	relay	S	switch	X	socket
DL	delay line	L	inductor	T	transformer	XDS	lampholder
DS	lamp	M	meter	TB	terminal board	XF	fuseholder
E	misc electronic part	MP	mechanical part	TC	thermocouple	Y	crystal
F	fuse	P	plug	TP	test point	Z	network

number of the subscript indicates the number of the change in backdating which should be referred to.

6-10. PROPRIETARY PARTS.

6-11. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard Instruments.

Table 6-2. Code List of Manufacturers.

Mfr. No.	Manufacturer Name	Address
01121	Allen-Bradley Co.	Milwaukee, WI 53204
01928	RCA Corp Solid State Div	Somerville, NJ 08876
03888	KDI Pyrofilm Corp	Whippany, NJ 07981
04713	Motorola Semiconductor Products	Phoenix, AZ 85062
06001	GE Co Elek Cap & Bat Prod Dept	Irmo, SC 29063
13103	Thermalloy Co	Dallas, TX 75234
17856	Siliconix Inc	Santa Clara, CA 95054
18178	Vactec Inc	Maryland Hgts, MO 63043
19701	Mepco/Electra Corp	Mineral Wells, TX 67067
24546	Corning Glass Works (Bradford)	Bradford, PA 16701
27014	National Semiconductor Corp	Santa Clara, CA 95051
28480	Hewlett-Packard Co Corporate Hq	Palo Alto, CA 94304
34371	Harris Semicon Div Harris-Intertype	Melbourne, FL 32901
56289	Sprague Electric Co	North Adams, MA 01247
72136	Electro Motive Corp Sub IEC	Willimantic, CT 06226
74970	Johnson E F Co	Waseca, MN 56093
75915	Littlefuse Inc	Des Plaines, IL 60016
91637	Dale Electronics Inc	Columbus, NE 68601

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	00339-66501	1	PC ASSEMBLY OSCILLATOR	28480	00339-66501
A1C1	0160-4601	1	CAPACITOR-FXD 5.6UF +-1% 200VDC	28480	0160-4601
A1C2	0160-4603	1	CAPACITOR-FXD .56UF +-1% 200VDC	28480	0160-4603
A1C3	0160-4598	1	CAPACITOR-FXD .056UF +-1% 200VDC	28480	0160-4598
A1C4	0160-4595	1	CAPACITOR-FXD 5600PF +-1% 200VDC	28480	0160-4595
A1C5	0160-4594	1	CAPACITOR-FXD 560PF +-1% 200VDC	28480	0160-4594
A1C6	0140-0190	1	CAPACITOR-FXD 39PF +-5% 300VDC	72136	DM15E390J0300WV1CR
A1C7	0121-0147	2	CAPACITOR-V TRMR-AIR 2.9-9.3PF 350V	74970	189-0507-5
A1C10	0160-3622	47	CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C11	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C12	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C13	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C14	0160-0363	2	CAPACITOR-FXD 620PF +-5% 300VDC MICA 0-70	28480	0160-0363
A1C15	0160-2201	1	CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201
A1C16	0160-2244	3	CAPACITOR-FXD 3PF +-.25PF 500VDC	28480	0160-2244
A1C17	0160-2306	3	CAPACITOR-FXD 27PF +-5% 300VDC	28480	0160-2306
A1C20 ΔA					
A1C21	0180-1745	1	CAPACITOR-FXD 1.5UF+-10% 20VDC TA	56289	150D155X9020A2
A1C22	0180-0195	1	CAPACITOR-FXD .33UF+-20% 35VDC TA	56289	150D334X0035A2
A1C23	0180-0218	1	CAPACITOR-FXD .15UF+-10% 35VDC TA	56289	150D154X9035A2
A1C24	0160-0194	1	CAPACITOR-FXD .015UF +-10% 200VDC POLYE	56289	292P15392
A1C25	0180-1704	7	CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A1C26	0180-0374	7	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A1C27	0180-2291	8	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A1C28	0180-1743	1	CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A1C30	0180-0106	1	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X0006B2
A1C32	0160-2306		CAPACITOR-FXD 27PF +-5% 300VDC	28480	0160-2306
A1C35	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C40	0180-0387	3	CAPACITOR-FXD 4.7UF+-5% 20VDC TA	56289	150D475X5020B2
A1C41	0180-0387		CAPACITOR-FXD 4.7UF+-5% 20VDC TA	56289	150D475X5020B2
A1C42	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C43	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A1C44	0160-2244		CAPACITOR-FXD 3PF +-.25PF 500VDC	28480	0160-2244
A1C45	0160-2306		CAPACITOR-FXD 27PF +-5% 300VDC	28480	0160-2306
A1C46	0160-0363		CAPACITOR-FXD 620PF +-5% 300VDC MICA 0-70	28480	0160-0363
A1C47 *	0160-0362	2	CAPACITOR-FXD 510PF +-5% 300VDC MICA 0-70	28480	0160-0362
A1C48	0160-0362		CAPACITOR-FXD 510PF +-5% 300VDC MICA 0-70	28480	0160-0362
A1C49	0160-2261	2	CAPACITOR-FXD 15PF +-5% 500VDC CER 0+-30	28480	0160-2261
A1CR1 ΔA					
A1CR2	1901-0518	2	DIODE-SCHOTTKY	28480	1901-0518
A1CR3	1901-0040	10	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR6	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A1CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR10	1901-0025	4	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR11	1902-0029	2	DIODE-ZNR 12.1V 5% DO-15 PD=1W TC=+.064%	28480	1902-0029
A1CR12	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR13	1902-0029		DIODE-ZNR 12.1V 5% DO-15 PD=1W TC=+.064%	28480	1902-0029
A1CR14	1901-0040		DIODE-SWITCHING 30V 2NS 50MA DO-35	28480	1901-0040
A1J1	1251-3192	3	CONNECTOR 3-PIN M POST TYPE	27264	09-64-1031(2403-03A)
A1J2	1251-3192		CONNECTOR 3-PIN M POST TYPE	27264	09-64-1031(2403-03A)
A1J3	1251-3196	2	CONNECTOR 8-PIN M POST TYPE	27264	09-64-1081(2403-08A)
A1J4	1251-0523	1	CONNECTOR 5-PIN M POST TYPE	27264	09-60-1051
A1J5	1251-2969	12	CONNECTOR-SNG, SINGLE JACK	27264	15-29-0501
A1J6	1251-3618	1	CONNECTOR 2-PIN M POST TYPE	27264	09-65-1021
A1K1	0490-1137	2	RELAY, REED	28480	0490-1137
A1Q1 ΔA					
A1Q2	1855-0265	1	TRANSISTOR FET VCR2N	28480	1855-0265
A1R1	0699-0025	2	RESISTOR 28.42K .25% .125W F TC=0+-50	28480	0699-0025
A1R2	0699-0025		RESISTOR 28.42K .25% .125W F TC=0+-50	28480	0699-0025
A1R3	0699-0026	2	RESISTOR 14.21K .25% .125W F TC=0+-50	28480	0699-0026
A1R4	0699-0026		RESISTOR 14.21K .25% .125W F TC=0+-50	28480	0699-0026
A1R5	0699-0027	2	RESISTOR 9.474K .25% .125W F TC=0+-50	28480	0699-0027
A1R6	0699-0027		RESISTOR 9.474K .25% .125W F TC=0+-50	28480	0699-0027
A1R7	0699-0028	2	RESISTOR 7.105K .25% .125W F TC=0+-50	28480	0699-0028
A1R8	0699-0028		RESISTOR 7.105K .25% .125W F TC=0+-50	28480	0699-0028
A1R9	0699-0040	4	RESISTOR 5.684K .25% .125W F TC=0+-50	01070	*
A1R10	0699-0040		RESISTOR 5.684K .25% .125W F TC=0+-50	01070	*
A1R11	0699-0040		RESISTOR 5.684K .25% .125W F TC=0+-50	01070	*
A1R12	0699-0040		RESISTOR 5.684K .25% .125W F TC=0+-50	01070	*
A1R13	0699-0035	2	RESISTOR 284.2K .25% .125W F TC=0+-50	01070	*
A1R14	0699-0035		RESISTOR 284.2K .25% .125W F TC=0+-50	01070	*
A1R15	0699-0036	2	RESISTOR 142.1K .25% .125W F TC=0+-50	01070	*

ΔA The oscillator circuit has been changed beginning with serial number 1730A00266. For instruments with lower serial numbers, refer to Section VII.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R16	0699-0036		RESISTOR 142.1K .25% .125W F TC=0+-50	0107D	B
A1R17	0699-0031	2	RESISTOR 94.74K .25% .125W F TC=0+-50	0107D	B
A1R18	0699-0031		RESISTOR 94.74K .25% .125W F TC=0+-50	0107D	B
A1R19	0699-0032	2	RESISTOR 71.05K .25% .125W F TC=0+-50	0107D	A
A1R20	0699-0032		RESISTOR 71.05K .25% .125W F TC=0+-50	0107D	A
A1R21	0699-0033	2	RESISTOR 56.84K .25% .125W F TC=0+-50	0107D	A
A1R22	0698-0033		RESISTOR 56.84K .25% .125W F TC=0+-50	0107D	B
A1R23, R24	0698-4536		RESISTOR 232K 1% .125W F TC=0+-100	03292	CA-1/8-T0-2323-F
A1R27	0698-3518	2	RESISTOR 7.32K 1% .125W F TC=0+-100	03292	CA-1/8-T0-7321-F
A1R28	0698-3492	2	RESISTOR 2.87K 1% .125W F TC=0+-100	03292	CA-1/8-T0-2871-F
A1R29	0757-0401	6	RESISTOR 100 1% .125W F TC=0+-100	03292	CA-1/8-T0-101-F
A1R30	2100-0567	2	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	72-168-0
A1R31	0698-4438	1	RESISTOR 3.24K 1% .125W F TC=0+-100	03292	CA-1/8-T0-3241-F
A1R32 ΔA					
A1R33 ΔA					
A1R34	0698-4440	2	RESISTOR 3.4K 1% .125W F TC=0+-100	03292	CA-1/8-T0-3401-F
A1R35	0698-3279	7	RESISTOR 4.99K 1% .125W F TC=0+-100	03292	CA-1/8-T0-4991-F
A1R36	0698-5094	1	RESISTOR 5.1M 5% .25W FC TC=-900/+1100	01121	CB5155
A1R37	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	CA-1/8-T0-101-F
A1R40	0757-0472	2	RESISTOR 200K 1% .125W F TC=0+-100	03292	CA-1/8-T0-2003-F
A1R41	0698-3228	11	RESISTOR 49.9K 1% .125W F TC=0+-100	28480	CC
A1R42	0757-0442	21	RESISTOR 10K 1% .125W F TC=0+-100	03292	CA-1/8-T0-1002-F
A1R43	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	CA-1/8-T0-1002-F
A1R44	0757-0416	1	RESISTOR 511 1% .125W F TC=0+-100	03292	CA-1/8-T0-511R-F
A1R45	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	CA-1/8-T0-1002-F
A1R46	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	03292	CA-1/8-T0-4991-F
A1R50	0757-0283	5	RESISTOR 2K 1% .125W F TC=0+-100	03292	CA-1/8-T0-2001-F
A1R51	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	03292	CA-1/8-T0-2001-F
A1R52	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	CA-1/8-T0-101-F
A1R53	0757-0407	3	RESISTOR 200 1% .125W F TC=0+-100	03292	CA-1/8-T0-201-F
A1R61	0698-3496	1	RESISTOR 3.57K 1% .125W F TC=0+-100	03292	CA-1/8-T0-3571-F
A1R62	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	03292	CA-1/8-T0-4991-F
A1R63	0698-4470	2	RESISTOR 698 1% .5W F TC=0+-100	05524	CMF-65-2
A1R64	0698-4492	1	RESISTOR 1.67K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R65	0698-3406	1	RESISTOR 1.33K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R66	0698-3479	5	RESISTOR 1.74K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R67	0698-4488	4	RESISTOR 1.18K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R68	0698-3479		RESISTOR 1.74K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R69	0698-4488		RESISTOR 1.18K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R70	0698-3479		RESISTOR 1.74K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R71	0698-4488		RESISTOR 1.18K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R72	0698-3479		RESISTOR 1.74K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R73	0698-4488		RESISTOR 1.18K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R74	0698-3479		RESISTOR 1.74K 1% .5W F TC=0+-100	05524	CMF-65-2
A1R75	0698-3476	1	RESISTOR 825 1% .5W F TC=0+-100	05524	CMF-65-2
A1R76	0698-4470		RESISTOR 698 1% .5W F TC=0+-100	05524	CMF-65-2
A1R78	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	CA-1/8-T0-101-F
A1R80	0757-0280	4	RESISTOR 1K 1% .125W F TC=0+-100	03292	CA-1/8-T0-1001-F
A1S6	00339-61902	1	SWITCH ASSEMBLY, MULTIPLIER	28480	00339-61902
	3100-3421	1	SWITCH, ROTARY	28480	3100-3421
A1S7	00339-61903	1	SWITCH ASSEMBLY, UNITS	28480	00339-61903
	3100-3422	2	SWITCH, ROTARY	28480	3100-3422
A1S8	00339-61904	1	SWITCH ASSEMBLY, TENTHS	28480	00339-61904
	3100-3422		SWITCH, ROTARY	28480	3100-3422
	5040-6259	15	SHAFT, EXTENDER	28480	5040-6259
	1500-0014	12	COUPLER, #1610	05104	128
A1U1	1826-0487	3	IC OP AMP	28480	1826-0487
A1U2	1826-0315	6	IC OP AMP	03406	LM1458
A1U3 Δ	1826-0487	7	IC OP AMP TO-99	28480	1826-0487
A2	00339-66502	1	PC ASSEMBLY, DETECTOR	28480	00339-66502
A2C1	0160-0163	3	CAPACITOR-FXD .033UF +-10% 200VDC POLYE	04203	292P33392
A2C2	0160-0163		CAPACITOR-FXD .033UF +-10% 200VDC POLYE	04203	292P33392
A2C3	0160-0163		CAPACITOR-FXD .033UF +-10% 200VDC POLYE	04203	292P33392
A2C4	0160-0341	1	CAPACITOR-FXD 6800PF +-1% 300VDC MICA-TC	28480	0160-0341
A2C5	0160-2201		CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201
A2C6	0160-4317	1	CAPACITOR-FXD 1200PF +-1% 100VDC	28480	0160-4317
A2C7	0160-3156	1	CAPACITOR-FXD 750PF +-1% 300VDC MICA-TC	28480	0160-3156
A2C8	0160-3691	1	CAPACITOR-FXD 75PF +-5% 100VDC	28480	0160-3691
A2C9	0160-3924	1	CAPACITOR-FXD 1700PF +-1% 100VDC	28480	0160-3924
A2C10	0170-0038	1	CAPACITOR-FXD .22UF +-10% 200VDC POLYE	28480	0170-0038
A2C11	0160-2257	3	CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A2C12	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C13	0160-2244	4	CAPACITOR-FXD 3PF +-.25PF 500VDC	28480	0160-2244
A2C14	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C15	0160-2201		CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201

See introduction to this section for ordering information

ΔA The oscillator circuit has been changed beginning with serial number 1730A00266. For instrument with lower serial numbers, refer to Section VII.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2C16	0180-2062	2	CAPACITOR-FXD 120UF+-20% 10VDC TA	56289	150D127X0010S2
A2C17	0180-2062		CAPACITOR-FXD 120UF+-20% 10VDC TA	56289	150D127X0010S2
A2C18	0180-0373	1	CAPACITOR-FXD .68UF+-10% 35VDC TA	56289	150D684X9035A2
A2C19	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C20	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C21	0160-2940	2	CAPACITOR-FXD 470PF +-5% 300VDC MICA-TC	28480	0160-2940
A2C22	0180-1775	1	CAPACITOR-FXD 1.5UF+-10% 35VDC TA	56289	150D155X9035B2
A2C23	0180-1746	2	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A2C24	0180-0559	1	CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A2C25	0160-2204	6	CAPACITOR-FXD 100PF +-5% 300VDC MICA-TC	28480	0160-2204
A2C27	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C28	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C30	0180-1746		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A2C31	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C32	0160-2940		CAPACITOR-FXD 470PF +-5% 300VDC MICA-TC	28480	0160-2940
A2C33	0180-0100	1	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A2C34	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C35	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A2C36	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C37	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A2C38	0160-2261		CAPACITOR-FXD 15PF +-5% 500VDC CER 0+-30	28480	0160-2261
A2CR1 Δ	1902-0938	A	DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	28480	1902-0938
A2CR2 Δ	1902-0938		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	28480	1902-0938
A2CR3	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR5	1902-3128	1	DIODE-ZNR 7.32V 5% DO-7 PD=.4W TC=+.043%	02235	FZ-247
A2E1	1990-0630	1	PHOTO-MODULE	28480	1990-0630
A2F1	2110-0011	1	FUSE .062A 250V SLO-BLO 1.25X.25 UL IEC	75915	313.062
	2110-0269	2	FUSEHOLDER-CLIP TYPE .250-FUSE	28480	2110-0269
A2J1	1251-2969		CONNECTOR-PHONO, SINGLE JACK	27264	15-24-0501
A2J2	1251-2969		CONNECTOR-PHONO, SINGLE JACK	27264	15-24-0501
A2J3	1251-2969		CONNECTOR-PHONO, SINGLE JACK	27264	15-24-0501
A2J4	1251-2969		CONNECTOR-PHONO, SINGLE JACK	27264	15-24-0501
A2J200	1251-3186		CONNECTOR 8-PIN M POST TYPE	27264	09-60-1081(2403-08A)
A2J201	1251-3195	1	CONNECTOR 4-PIN M POST TYPE	27264	09-60-1041(2403-04A)
A2J202	1251-3618		CONNECTOR 2-PIN M POST TYPE	27264	09-60-1021
A2J203	1251-2034	1	CONNECTOR-PC EDGE 10-CONT/ROW 2-ROWS	04526	252-10-30-300
A2K1	0490-0563	1	RELAY 2C 12VDC-COIL 5A 115VAC	28480	0490-0563
	0490-0568	1	SOCKET-RLY 11-CONT DIP-SLDR	28480	0490-0568
A2Q1	1855-0082	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0082
A2Q2	1854-0071	3	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q3	1855-0386	2	TRANSISTOR J-FET 2N4392 N-CHAN D-MODE	02735	2N4392
A2R1	0698-3498	1	RESISTOR 8.66K 1% .125W F TC=0+-100	03292	C4-1/8-T0-8661-F
A2R2	0698-4440		RESISTOR 3.4K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3401-F
A2R3	0698-4501	1	RESISTOR 59K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5902-F
A2R4	0698-4445	5	RESISTOR 5.76K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5761-F
A2R5	0698-4445		RESISTOR 5.76K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5761-F
A2R6	0698-4445		RESISTOR 5.76K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5761-F
A2R7	0698-3268	3	RESISTOR 11.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1152-F
A2R8	0698-3268		RESISTOR 11.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1152-F
A2R9	0698-3268		RESISTOR 11.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1152-F
A2R10	0698-7332		RESISTOR 1M 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1004-F
A2R11	0699-0053	1	RESISTOR 50.51 .25% .125W F TC=0+-50	28480	0699-0053
A2R12	0698-3237	1	RESISTOR 5K .25% .125W F TC=0+-50	03292	NC55
A2R13	0812-0099	2	RESISTOR 1K 5% 5W PW TC=0+-20	05524	RS-5
A2R14	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	C4-1/8-T0-101-F
A2R15	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A2R16	0757-0422		RESISTOR 909 1% .125W F TC=0+-100	03292	C4-1/8-T0-909R-F
A2R17	2100-3212	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	04568	72-103-0
A2R18	0757-0278	1	RESISTOR 1.78K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1781-F
A2R20	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A2R21	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A2R22	2100-0568	1	RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	73138	72-102-0
A2R23	0698-4442	1	RESISTOR 4.42K 1% .125W F TC=0+-100	03292	C4-1/8-T0-4421-F
A2R24	2100-3211	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	72-105-0
A2R25	0698-3453	1	RESISTOR 196K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1963-F
A2R26	0757-0497	2	RESISTOR 825K 1% .125W F TC=0+-100	05524	CMF-55-1
A2R27 ΔA	0698-3557		RESISTOR 806 1% .125W F TC=0+-100	03292	C4-1/8-T0-806R-F
A2R28	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A2R29	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	03292	C4-1/8-T0-4991-F
A2R30	0757-0444	1	RESISTOR 12.1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1212-F
A2R31	0757-0420	1	RESISTOR 750 1% .125W F TC=0+-100	03292	C4-1/8-T0-751-F

ΔA Refer to note ΔA on Figure 8-16.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R32	0757-0410	1	RESISTOR 301 1% .125W F TC=0+-100	24546	C4-1/8-T0-301R-F
A2R33	0698-3225	1	RESISTOR 1.43K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1431-F
A2R34	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R35	2100-3561		RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	73138	72-206-0
A2R36	2100-3211	1	RESISTOR-TRMR 200K 10% C TOP-ADJ 1-TRN	73138	72-143-0
A2R37	2100-3210	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	73138	72-108-0
A2R38	0698-6320	1	RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A2R39	0699-0034	1	RESISTOR 2.312K .25% .125W F TC=0+-50	[illegible]	[illegible]
A2R40	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R41	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R42	0698-4443	1	RESISTOR 4.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4531-F
A2U1	1826-0315		IC OP AMP	[illegible]	[illegible]
A2U4 ΔA	1826-0487		IC OP AMP	28480	1826-0487
A2U5	1826-0421	2	IC LINEAR 536J	28480	1826-0421
A2U6	1820-0203	3	IC 741 OP AMP	07263	741CE009
A2U7	1826-0421		IC LINEAR 536J	28480	1826-0421
A2U8	1826-0315		IC OP AMP	[illegible]	[illegible]
A2U9	1820-0203		IC 741 OP AMP	07263	741CE009
A2U10	1826-0081	5	IC 318 OP AMP	[illegible]	LM318
A2U12	1820-0203		IC 741 OP AMP	02237	UA741HC
A2U13	1826-0021	2	IC OP AMP	[illegible]	LM310
A3	00339-66503	1	PC ASSEMBLY, ANALYZER-POWER SUPPLY	28480	00339-66503
A3C1	0160-2132	1	CAPACITOR-FXD .5UF +-10% 50VDC POLYE	84411	[illegible]-245
A3C2	0160-0165	1	CAPACITOR-FXD .056UF +-10% 200VDC POLYE	56289	292P56392
A3C3	0160-0158	1	CAPACITOR-FXD 5600PF +-10% 200VDC POLYE	56289	292P56292
A3C4	0160-3535	1	CAPACITOR-FXD 560PF +-5% 300VDC MICA+70	28480	0160-3535
A3C5	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C6	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C7	0160-2250		CAPACITOR-FXD 5.1PF +-.25PF 500VDC	28480	0160-2250
A3C10	0160-2257		CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A3C11	0160-4589	1	CAPACITOR-FXD 1.8UF +-1% 200VDC POLYE	28480	0160-4589
A3C12	0160-4590	1	CAPACITOR-FXD .18UF +-1% 200VDC POLYE	28480	0160-4590
A3C13	0160-4591	1	CAPACITOR-FXD .018UF +-1% 200VDC POLYE	28480	0160-4591
A3C14	0160-4592	1	CAPACITOR-FXD .0018UF +-1% 200VDC POLYE	28480	0160-4592
A3C15	0160-2206	1	CAPACITOR-FXD 160PF +-5% 300VDC MICA+70	28480	0160-2206
A3C16	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C17	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C18	0121-0147		CAPACITOR-V TRMR-AIR 2-14.3PF 350V	74970	189-507-5
A3C19	0160-2250		CAPACITOR-FXD 5.1PF +-.25PF 500VDC	28480	0160-2250
A3C20	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C21	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C22	0160-2257		CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A3C23	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C24	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C25	0160-2257		CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A3C26	0160-2201		CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201
A3C27	0160-2201		CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201
A3C100	0160-2251	4	CAPACITOR-FXD 5.6PF +-.25PF 500VDC	28480	0160-2251
A3C102	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C103	0140-0200	2	CAPACITOR-FXD 390PF +-5% 300VDC MICA+70	72136	DM15F391J0300WV1CR
A3C104	0140-0200		CAPACITOR-FXD 390PF +-5% 300VDC MICA+70	72136	DM15F391J0300WV1CR
A3C105	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C106	0160-2200	1	CAPACITOR-FXD 43PF +-5% 300VDC	28480	0160-2200
A3C107	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C108	0160-2249	3	CAPACITOR-FXD 4.7PF +-.25PF 500VDC	28480	0160-2249
A3C109	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C110	0140-0192	1	CAPACITOR-FXD 68PF +-5% 300VDC	72136	DM15E680J0300WV1CR
A3C111	0180-1715	2	CAPACITOR-FXD 150UF+-10% 6VDC TA	56289	150D157X9006R2
A3C112	0180-1715		CAPACITOR-FXD 150UF+-10% 6VDC TA	56289	150D157X9006R2
A3C113	0160-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA+70	28480	0160-2204
A3C114	0160-0363	1	CAPACITOR-FXD 820PF +-5% 300VDC MICA+70	28480	0160-0363
A3C115	0160-2263	1	CAPACITOR-FXD 18PF +-5% 500VDC	28480	0160-2263
A3C116	0140-0195	1	CAPACITOR-FXD 130PF +-5% 300VDC MICA	04522	DM15F131J0300WV1CR
A3C117	0160-2249		CAPACITOR-FXD 4.7PF +-.25PF 500VDC	28480	0160-2249
A3C120	0160-2220	1	CAPACITOR-FXD 1200PF +-5% 300VDC	28480	0160-2220
A3C121	0160-2209	1	CAPACITOR-FXD 360PF +-5% 300VDC MICA+70	28480	0160-2209
A3C122	0160-2201		CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201
A3C130	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C131	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C132 ΔA	0160-2249		CAPACITOR-FXD 4.7PF +-.25PF 500VDC	28480	0160-2249
A3C133	0160-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA+70	28480	0160-2204
A3C134	0160-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA+70	28480	0160-2204

See introduction to this section for ordering information

ΔA Refer to note ΔA on Figure 8-13.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3C135	0160-2257		CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A3C200	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C201	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C202	0160-2250		CAPACITOR-FXD 5.1PF +-.25PF 500VDC	28480	0160-2250
A3C203	0160-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA 0+70	28480	0160-2204
A3C204	0160-2201		CAPACITOR-FXD 51PF +-5% 300VDC	28480	0160-2201
A3C205	0160-2244	1	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2244
A3C206	0180-1734		CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A3C207	0180-1704		CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A3C300	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C301	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C302	0160-2628	2	CAPACITOR-FXD .03UF +-20% 500VDC CER	28480	0160-2628
A3C303	0160-2628		CAPACITOR-FXD .03UF +-20% 500VDC CER	28480	0160-2628
A3C304	0180-2635	4	CAPACITOR-FXD 1000UF+50-10% 35VDC AL	28480	0180-2635
A3C305	0180-2635		CAPACITOR-FXD 1000UF+50-10% 35VDC AL	28480	0180-2635
A3C306	0180-2635		CAPACITOR-FXD 1000UF+50-10% 35VDC AL	28480	0180-2635
A3C307	0180-2635		CAPACITOR-FXD 1000UF+50-10% 35VDC AL	28480	0180-2635
A3C308	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C309	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A3C310	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C311	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C312	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C320	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C321	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C322	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C323	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C324	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3CR100	1902-0554	2	DIODE-ZNR 10V 5% DO-15 PD=1W TC=+.063%	28480	1902-0554
A3CR101	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A3CR102	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A3CR103	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A3CR104	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A3CR105	1902-0554		DIODE-ZNR 10V 5% DO-15 PD=1W TC=+.063%	28480	1902-0554
A3CR106	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR200	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR201	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR300	1906-0096	2	DIODE-FW BRDG 200V 2A	04713	MDA202
A3CR301	1906-0096		DIODE-FW BRDG 200V 2A	04713	MDA202
A3CR302	1902-0933	2	DIODE-ZENER 58.2V	28480	1902-0933
A3CR303	1902-0933		DIODE-ZENER 58.2V	28480	1902-0933
A3E1	1990-0644	2	PHOTOMODULE	28480	1990-0644
A3E2	1990-0644		PHOTOMODULE	28480	1990-0644
A3F100	2110-0011		FUSE .062A 250V NORM-BLO 1.25X.25 UL IEC	75915	312.062
	2110-0269		FUSEHOLDER-CLIP TYPE .250-FUSE	28480	2110-0269
A3J1	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J2	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J3	1251-2035	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	04506	252-15-30-300
A3J100	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J101	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J102	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J201	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J202	1251-2969		CONNECTOR;PHONO, SINGLE JACK	27264	15-24-0501
A3J300	1251-3981	1	CONNECTOR 4-PIN M POST TYPE	27264	09-60-1091
A3J301	1251-3192		CONNECTOR 3-PIN M POST TYPE	27264	09-60-1031(2403-0311)
A3J302	1251-3615		CONNECTOR 2-PIN M POST TYPE	27264	09-60-1021
A3Q100	1855-0360	1	TRANSISTOR MOSFET N-CHAN D-MODE TO-72 SI	28480	1855-0360
	1205-0333		HEAT SINK	28480	1205-0333
A3Q300	1854-0072	2	TRANSISTOR NPN 2N3054 SI TO-66 PD=25W	01928	2N3054
	1205-0333		HEAT SINK	28480	1205-0333
A3Q301	1854-0072		TRANSISTOR NPN 2N3054 SI TO-66 PD=25W	01928	2N3054
A3R1	0698-3449	2	RESISTOR 28.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2872-F
A3R2	0698-3307	2	RESISTOR 14.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1432-F
A3R3	0698-4020	2	RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A3R4	0698-4471	2	RESISTOR 7.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7151-F
A3R5	0757-0200	2	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R6	0757-0200		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A3R7	0698-3456	1	RESISTOR 287K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2873-F
A3R8	0698-4520	1	RESISTOR 143K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1433-F
A3R9	0757-0978	1	RESISTOR 95.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9532-F
A3R10	0698-0505	1	RESISTOR 71.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7152-F
A3R11	0757-0459	1	RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A3R12	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R13	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R14	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A3R20	0698-3449		RESISTOR 28.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2872-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R21	0698-4307		RESISTOR 19.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1932-F
A3R22	0698-4020		RESISTOR 9.53K 1% .125W F TC=0+-100	03292	C4-1/8-T0-9531-F
A3R23	0698-4471		RESISTOR 7.15K 1% .125W F TC=0+-100	03292	C4-1/8-T0-7151-F
A3R24	0698-4445		RESISTOR 5.76K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5761-F
A3R25	0698-4445		RESISTOR 5.76K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5761-F
A3R26	0698-3456		RESISTOR 287K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2873-F
A3R27	0698-4520		RESISTOR 143K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1433-F
A3R28	0757-0874		RESISTOR 95.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-9532-F
A3R29	0698-4505		RESISTOR 71.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-7152-F
A3R30	0698-4500	2	RESISTOR 57.6K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5762-F
A3R31	0757-0455	1	RESISTOR 36.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3652-F
A3R32	0698-4461	1	RESISTOR 16.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1652-F
A3R33	0698-4477	1	RESISTOR 10.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1052-F
A3R34	0698-3259	1	RESISTOR 7.87K 1% .125W F TC=0+-100	03292	C4-1/8-T0-7871-F
A3R35	0757-0290	1	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A3R36	0698-3515	1	RESISTOR 5.9K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5901-F
A3R37	0698-3456		RESISTOR 287K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2873-F
A3R38	0698-4520		RESISTOR 143K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1433-F
A3R39	0757-0874		RESISTOR 95.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-9532-F
A3R40	0698-4505		RESISTOR 71.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-7152-F
A3R41	0698-4500		RESISTOR 57.6K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5762-F
A3R42	0698-3161	1	RESISTOR 38.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3832-F
A3R43	0757-0451	1	RESISTOR 24.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2432-F
A3R44	0698-4483	1	RESISTOR 12.7K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1272-F
A3R45	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1001-F
A3R46	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1001-F
A3R47	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1001-F
A3R48	0757-0446	1	RESISTOR 15K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1502-F
A3R49	0698-3152	1	RESISTOR 3.48K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3481-F
A3R50	0698-4421	1	RESISTOR 249 1% .125W F TC=0+-100	03292	C4-1/8-T0-249R-F
A3R51	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2001-F
A3R56	0757-0440	1	RESISTOR 7.5K 1% .125W F TC=0+-100	03292	C4-1/8-T0-7501-F
A3R57	0698-3382	1	RESISTOR 5.49K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5491-F
A3R100	0699-0030	1	RESISTOR 68.38K .25%	28480	0699-0030
A3R101	0699-0029	1	RESISTOR 21.82K .25%	28480	0699-0029
A3R102	0698-8997	1	RESISTOR 6.808K .25%	28480	0698-8997
A3R103	0699-0028	1	RESISTOR 2.162K .25%	28480	0699-0028
A3R104	0698-5439	1	RESISTOR 1K .25% .125W F TC=0+-50	03292	5C45
A3R106	0698-3492		RESISTOR 2.61K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2611-F
A3R107	0698-1514		RESISTOR 7.32K 1% .125W F TC=0+-100	03292	C4-1/8-T0-7321-F
A3R110	0811-1856	1	RESISTOR 500 5% 5W PW TC=0+-20	05520	95-5
A3R111	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2001-F
A3R112	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2001-F
A3R113	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A3R114	0698-6320		RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A3R116	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	C4-1/8-T0-101-F
A3R120	0699-0039	2	RESISTOR 163.3 .25% .125W F TC=0+-50	01070	#
A3R121	0699-0038	2	RESISTOR 555.6 .25% .125W F TC=0+-50	01070	#
A3R122	0699-0034		RESISTOR 2.312K .25% .125W F TC=0+-50	01070	#
A3R130	0698-4200	2	RESISTOR 3.419K .25% .125W F TC=0+-100	03888	PME55-1/8-T0-3491B-C
A3R131	0698-4197	2	RESISTOR 1.081K .25% .125W F TC=0+-100	03888	PME55-1/8-T0-1081B-C
A3R132	0698-4193	2	RESISTOR 341.9 .25% .125W F TC=0+-100	03888	PME55-1/8-T0-341R9-C
A3R133	0698-4192	2	RESISTOR 108.1 .25% .125W F TC=0+-100	03888	PME55-1/8-T0-108R1-C
A3R134	0698-6998	2	RESISTOR 34.19 .25% .125W F TC=0+-50	01070	#
A3R135	0698-6999	2	RESISTOR 15.81 .25% .125W F TC=0+-100	01070	#
A3R140	8150-3375		WIRE, ELECTRICAL JUMPER	34672	ZEROHM
A3R150	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	C4-1/8-T0-101-F
A3R151	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	03292	C4-1/8-T0-4991-F
A3R200	0698-4200		RESISTOR 3.419K .25% .125W F TC=0+-100	03888	PME55-1/8-T0-3491B-C
A3R201	0698-4197		RESISTOR 1.081K .25% .125W F TC=0+-100	03888	PME55-1/8-T0-1081B-C
A3R202	0698-4193		RESISTOR 341.9 .25% .125W F TC=0+-100	03888	PME55-1/8-T0-341R9-C
A3R203	0698-4192		RESISTOR 108.1 .25% .125W F TC=0+-100	03888	PME55-1/8-T0-108R1-C
A3R204	0698-6998		RESISTOR 34.19 .25% .125W F TC=0+-50	01070	#
A3R205	0698-6999		RESISTOR 15.81 .25% .125W F TC=0+-100	01070	#
A3R210	0698-6320		RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A3R212	0699-0039		RESISTOR 163.3 .25% .125W F TC=0+-50	01070	#
A3R213	0699-0038		RESISTOR 555.6 .25% .125W F TC=0+-50	01070	#
A3R214	0699-0034		RESISTOR 2.312K .25% .125W F TC=0+-50	01070	#
A3R300	0683-0685	2	RESISTOR 6.8 5% .25W FC TC=-400/+500	01121	CB68G5
A3R301	0683-0685		RESISTOR 6.8 5% .25W FC TC=-400/+500	01121	CB68G5
A3R302	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A3R303	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A3R310	0686-0275	1	RESISTOR 2.7 5% .5W CC TC=0+412	01121	EB27G5
A3R311	0699-0037	1	RESISTOR 2.4 5% .5W CC TC=0+412	28480	0699-0037
A3R312	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A3R313	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3S1	00339-61905	1	SWITCH ASSEMBLY, MULTIPLIER	28480	00339-61905
	3100-3416	1	SWITCH ROTARY	28480	3100-3416
A3S2	00339-61906	1	SWITCH ASSEMBLY, UNITS	28480	00339-61906
	3100-3417	1	SWITCH ROTARY	28480	3100-3417
A3S3	00339-61907	1	SWITCH ASSEMBLY, TENTHS	28480	00339-61907
	3100-3418	1	SWITCH ROTARY	28480	3100-3418
A3S4	00339-61908	1	SWITCH ASSEMBLY, INPUT RANGE	28480	00339-61908
	3100-3419	1	SWITCH ROTARY	28480	3100-3419
A3S5	00339-61909	1	SWITCH ASSEMBLY, DISTORTION RANGE	28480	00339-61909
	3100-3420	1	SWITCH ROTARY	28480	3100-3420
	5040-6259		SHAFT, EXTENDER	28480	5040-6259
	1500-0019		COUPLER, RIGID	05104	128
A3U1	1826-0081		IC 318 OP AMP	03790	LM318
A3U2	1826-0081		IC 318 OP AMP	03790	LM318
A3U3	1826-0109		IC OP AMP	03791	MLM-2025-60595
A3U4	1826-0109		IC OP AMP	03791	MLM-2025-60595
A3U100, U101 ΔA	1826-0487		IC OP AMP TO-99	28480	1826-0487
A3U200	1826-0109		IC OP AMP	03791	MLM-2025-60595
A3U300	1826-0457	2	IC LINEAR LM 325H	28480	1826-0457
	1205-0050	1	HEAT SINK TO-5/TO-18-PKG	28480	1205-0050
A3U301	1826-0457		IC LINEAR LM 325H	28480	1826-0457
A4	00339-66504	1	PC ASSEMBLY, ERROR CONTROL	28480	00339-66504
A4C1	0180-1702	1	CAPACITOR-FXD 180UF+-20% 6VDC TA	56289	150D187X0006R2
A4C3	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C4	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C5	0180-1704		CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A4C7	0160-3847	2	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C8	0180-0387		CAPACITOR-FXD 4.7UF+-5% 20VDC TA	56289	150D475X5020B2
A4C9	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C10	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C11	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C12	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C13	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C14	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C15	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C21	0180-1704		CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A4C22	0180-1704		CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A4C24	0160-3847		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A4C25	0180-2235	1	CAPACITOR-FXD 650UF+-20% 15VDC TA	06001	MPR231067
A4C26	0180-0228	2	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C27	0180-0228		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C28	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C29	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C30	0160-3622		CAPACITOR-FXD .1UF +80-20% 100VDC CER	28480	0160-3622
A4C31	0180-1704		CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A4CR1	1902-1335		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	28480	1902-1335
A4CR2	1902-1335		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	28480	1902-1335
A4CR3	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR4	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR5	1902-3149	2	DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	02230	MZ7256
A4CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR7	1902-1335		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	28480	1902-1335
A4CR8	1902-1335		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	28480	1902-1335
A4CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR11	1902-3149		DIODE-ZNR 9.09V 5% DO-7 PD=.4W TC=+.057%	02230	MZ7256
A4CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR13	1902-3062		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	04713	SZ 10939-65
A4CR14	1902-3062		DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=-.049%	04713	SZ 10939-65
A4CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR18, 19, 20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR21	1901-0535		DIODE, SCHOTTKY	28480	1901-0535
A4K1	0490-1137		RELAY, REED	28480	0490-1137
A4L3, L4 ΔA	9170-0894	2	CORE-SHIELDING BEAD	28480	9170-0894
A4L1	9100-1643	2	COIL-MLD 300UH 5% Q=65 .190Dx.44LG	03276	19/303
A4L2	9100-1643		COIL-MLD 300UH 5% Q=65 .190Dx.44LG	03276	19/303
A4Q1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q2	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q3	1855-0386		TRANSISTOR J-FET 2N4392 N-CHAN D-MODE	01295	2N4392
A4R1	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R2	0757-0472		RESISTOR 200K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2003-F
A4R3	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R4	0757-0438	6	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R5	0757-0465	6	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F

ΔA Components L3 and L4 have been added to instruments with serial numbers 1730A00196 and greater. Refer to note ΔA on Figure 8-15.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4R6	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1003-F
A4R7	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A4R8	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A4R9	0757-0289	2	RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1332-F
A4R10	0757-0273	2	RESISTOR 3.01K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3011-F
A4R11	0757-0449	4	RESISTOR 20K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2002-F
A4R12	0698-0064	4	RESISTOR 9.31K 1% .125W F TC=0+-100	05524	CMF-1/8-T1-9311-F
A4R13	0698-4431	2	RESISTOR 2.05K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2051-F
A4R14	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5111-F
A4R15	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5111-F
A4R16	2100-3351	2	RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	73138	72-142-0
A4R17	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R18	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R19	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R20	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R21	0698-4486		RESISTOR 24.9K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2492-F
A4R22	0698-4486		RESISTOR 24.9K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2492-F
A4R23	0698-3446	2	RESISTOR 348 1% .125W F TC=0+-100	03292	C4-1/8-T0-348R-F
[illegible]	0757-0407		RESISTOR 200 1% .125W F TC=0+-100	03292	C4-1/8-T0-201-F
[illegible]	0757-0449		RESISTOR 20K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2002-F
A4R26	0698-0064		RESISTOR 9.31K 1% .125W F TC=0+-100	05524	CMF-1/8-T1-9311-F
A4R27	0757-0449		RESISTOR 20K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2002-F
A4R29	0698-0064		RESISTOR 9.31K 1% .125W F TC=0+-100	05524	CMF-1/8-T1-9311-F
A4R31	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5111-F
A4R32	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1003-F
A4R33	0757-0465		RESISTOR 100K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1003-F
A4R34	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A4R35	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1002-F
A4R36	0757-0289		RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1332-F
A4R37	0757-0449		RESISTOR 20K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2002-F
A4R38	0698-0064		RESISTOR 9.31K 1% .125W F TC=0+-100	05524	CMF-1/8-T1-9311-F
A4R39	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3011-F
A4R40	0698-4431		RESISTOR 2.05K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2051-F
A4R41	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5111-F
A4R42	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	03292	C4-1/8-T0-5111-F
A4R43	2100-3351		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	73138	72-142-0
A4R44	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R45	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R46	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R47	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	01606	CC
A4R48	0698-4435		RESISTOR 2.49K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2491-F
A4R49	0757-0447	2	RESISTOR 16.2K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1622-F
A4R50	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1001-F
A4R51	0757-0447		RESISTOR 16.2K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1622-F
A4R52	0698-4435		RESISTOR 2.49K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2491-F
A4R53	0757-0280	1	RESISTOR 1K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1001-F
A4R54	0698-4491	1	RESISTOR 30.9K 1% .125W F TC=0+-100	03292	C4-1/8-T0-3092-F
[illegible]	0698-4453		RESISTOR 402 1% .125W F TC=0+-100	03292	C4-1/8-T0-402R-F
[illegible]	0757-0407		RESISTOR 200 1% .125W F TC=0+-100	03292	C4-1/8-T0-201-F
A4R57	0757-0426	2	RESISTOR 1.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1301-F
A4R58	0757-0426		RESISTOR 1.3K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1301-F
A4R59	0757-0407		RESISTOR 200 1% .125W F TC=0+-100	03292	C4-1/8-T0-201-F
A4R60	0757-0407		RESISTOR 200 1% .125W F TC=0+-100	03292	C4-1/8-T0-201-F
A4R61	0698-4453	2	RESISTOR 402 1% .125W F TC=0+-100	03292	C4-1/8-T0-402R-F
A4R62	0698-0085	1	RESISTOR 2.61K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2611-F
A4R63	0698-4480	2	RESISTOR 649 1% .125W F TC=0+-100	03292	C4-1/8-T0-649R-F
A4R64	0698-4480		RESISTOR 649 1% .125W F TC=0+-100	03292	C4-1/8-T0-649R-F
A4R65	2100-3274	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	73138	72-146-0
A4R66	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	03292	C4-1/8-T0-1502-F
A4U1	1826-0081		IC 318 OP AMP	[illegible]	LM318
A4U2	1820-0427	2	IC 1496 MODULATOR	[illegible]	MC1496G
A4U3	1826-0315		IC OP AMP	[illegible]	LM348N
A4U4	1820-0427		IC 1496 MODULATOR	[illegible]	MC1496G
A4U5	1826-0315		IC OP AMP	[illegible]	LM348N
A4U6	1826-0315		IC OP AMP	[illegible]	LM348N
A4U7	1826-0021		IC OP AMP	[illegible]	LM310H
	0403-0214	1	EXTRACTOR-PC BOARD YEL POLYC	28480	0403-0214
	1480-0116	1	EXTRACTOR PIN-1/16" DIA	73957	GP24-081525U-12
A5	00339-66505	1	PC ASSEMBLY, INPUT FUNCTION	28480	00339-66505
		1		28480	0160-4593
A5C500	0160-3456	1	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A5C501	0180-0197	2	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C502	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C503	0160-0960	1	CAPACITOR-FXD 6200PF +-2% 300VDC	28480	0160-0960

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5C504	0160-2222	1	CAPACITOR-FXD 1500PF +-5% 300VDC	28480	0160-2222
A5C505	0160-2204		CAPACITOR-FXD 100PF +-5% 300VDC MICA 0+70	28480	0160-2204
A5C506	0160-2207	1	CAPACITOR-FXD 300PF +-5% 300VDC MICA 0+70	28480	0160-2207
A5C510	0160-4593	1	CAPACITOR-FXD 1.5UF +-20% 400VDC	28480	0160-4593
A5CR500	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5L500	9100-1666	1	COIL-MLD 3MH 5% Q=70 .215DX.54LG	02176	22-1312-30J
A5L501	9100-1672	1	COIL-MLD 6.2MH 5% Q=80 .24DX.74LG	03270	28/824
A5L502	9100-1664	1	COIL-MLD 4.3MH 5% Q=80 .20DX.74LG	02176	24-1313-21J
A5MP1	00339-01200	1	BRACKET, FUNCTION SWITCH	28480	00339-01200
A5R500	0698-3572	1	RESISTOR 60.4K 1% .125W F TC=0+-100	03298	C4-1/8-T0-6042-F
A5R501	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	03298	C4-1/8-T0-1001-F
A5R502	0757-0424	1	RESISTOR 1.1K 1% .125W F TC=0+-100	03298	C4-1/8-T0-1101-F
A5S9	00339-61901	1	SWITCH ASSEMBLY, FUNCTION	28480	00339-61901
	3100-3423	1	SWITCH, ROTARY	28480	3100-3425

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CHASSIS PARTS		
C1	0150-0012	1	CAPACITOR-FXD .01UF +-20% 1KVDC CER	[illegible]	C023A102J103-S38
DS1	1990-0487	4	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
	1450-0404	4	LENS CAP CLR-TL .125-DIA	28480	1450-0404
DS2	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
	1450-0404		LENS CAP CLR-TL .125-DIA	28480	1450-0404
DS3	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
	1450-0404		LENS CAP CLR-TL .125-DIA	28480	1450-0404
DS4	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
	1450-0404		LENS CAP CLR-TL .125-DIA	28480	1450-0404
F1	2110-0004	1	FUSE .25A 250V FAST-BLO 1.25X.25 UL IEC	04700	312.250
F2	2110-0384	1	FUSE .062A 125V FAST-BLO .281X.091	04700	275.062
FL1	9100-3875	1	FILTER	28480	9100-3875
J1	1510-0090	2	BINDING POST SGL SGL-TUR JGK	28480	1510-0090
	1510-0093	3	BINDING POST SGL SGL-TUR DBP BLK	28480	1510-0093
	2950-0144	3	NUT-HEX-DBL-CHAM 3/8-32-THD .156-THK	28480	2950-0144
J2	1250-0083	1	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	[illegible]	28JR-133-1
J3	1510-0038	1	BINDING POST SGL THD-STUD	28480	1510-0038
J4	1510-0091	1	BINDING POST SGL SGL-TUR JGK RED	28480	1510-0091
	1510-0093		BINDING POST SGL SGL-TUR DBP BLK	28480	1510-0093
	2950-0144		NUT-HEX-DBL-CHAM 3/8-32-THD .156-THK	28480	2950-0144
J5	1510-0090		BINDING POST SGL SGL-TUR JGK	28480	1510-0090
	1510-0093		BINDING POST SGL SGL-TUR DBP BLK	28480	1510-0093
	2950-0144		NUT-HEX-DBL-CHAM 3/8-32-THD .156-THK	28480	2950-0144
L1	9100-3447	1	COIL 40UH 25%	28480	9100-3447
L2	9100-3456	3	WIDE BAND CHOKE	28480	9100-3456
L3	9100-3456		WIDE BAND CHOKE	28480	9100-3456
L4	9100-3456		WIDE BAND CHOKE	28480	9100-3456
M1	1120-0991	1	METER	28480	1120-0991
S13	3101-1577	1	SWITCH, SLIDE DP3T-S(INPUT SELECT)	28480	3101-1577
S14	00339-61910	1	SWITCH ASSEMBLY, OSC, LEVEL	28480	00339-61910
	3100-3424		SWITCH ROTARY INCLUDES R3 (10KOHM)	28480	3100-3424
S14W1	00339-61601	1	CABLE ASSEMBLY, OSC, LEVEL	28480	00339-61601
	1251-3218	2	CONNECTOR, 8-PIN FEMALE	27264	09-50-7081
	1251-3073	29	CONTACT, CONNECTOR	27264	08-50-0107
S14W2	00339-61606	1	CABLE ASSEMBLY, OSCILLATOR LEVEL	28480	00339-61606
	1251-3201	1	CONNECTOR 3-PIN F POST TYPE	27264	09-50-7031
	1251-3613	3	CONNECTOR 2-PIN F POST TYPE	27264	09-50-7021
	1251-3073		CONTACT-CONN U/W-POST-TYPE FEM CRP	27264	08-50-0107
S17	3101-2042	2	SWITCH, SLIDE	28480	3101-2042
S18	3101-2042		SWITCH, SLIDE	28480	3101-2042
T1	9100-4012	1	TRANSFORMER, POWER	28480	9100-4012
	1251-3978	1	CONNECTOR 9-PIN F	27264	09-50-7091
	1251-3073		CONTACT-CONN U/W-POST-TYPE FEM CRP	27264	08-50-0107
W2	00339-61602	1	CABLE ASSEMBLY, OSC, POWER	28480	00339-61602
W2P2	1251-3201		CONNECTOR 3-PIN F POST TYPE	27264	09-50-7031
W2P301	1251-3201		CONNECTOR 3-PIN F POST TYPE	27264	09-50-7031
W3	00339-61603	1	CABLE ASSEMBLY, DETECTOR POWER	28480	00339-61603
W3P202	1251-3613		CONNECTOR 2-PIN F POST TYPE	27264	09-50-7021
W3P302	1251-3613		CONNECTOR 2-PIN F POST TYPE	27264	09-50-7021
	1251-3073		CONTACT-CONN U/W-POST-TYPE FEM CRP	27264	08-50-0107
W4	00339-61604	1	CABLE ASSEMBLY, METER RESPONSE	28480	00339-61604
W4P231	1251-3277	1	CONNECTOR 4-PIN F POST TYPE	27264	09-50-7041
	1251-3073		CONTACT-CONN U/W-POST-TYPE FEM CRP	27264	08-50-0107
W4R1	2100-3680	1	RESISTOR, VAR 5K (RELATIVE LEVEL)	28480	2100-3680
W4S12	3101-1235	1	SWITCH-SL DPDT-NS STD 1.5A 125VAC	05656	11A-1244A
W5	00339-61605	1	CABLE ASSEMBLY, FILTER	28480	00339-61605
W5P200	1251-3278		CONNECTOR 8-PIN F POST TYPE	27264	09-50-7081
	1251-3073		CONTACT-CONN U/W-POST-TYPE FEM CRP	27264	08-50-0107
W5S11	3101-2247	1	FILTER SWITCH	28480	3101-2247
	5041-0117	1	KEY CAP FILTER SWITCH	28480	5041-0117

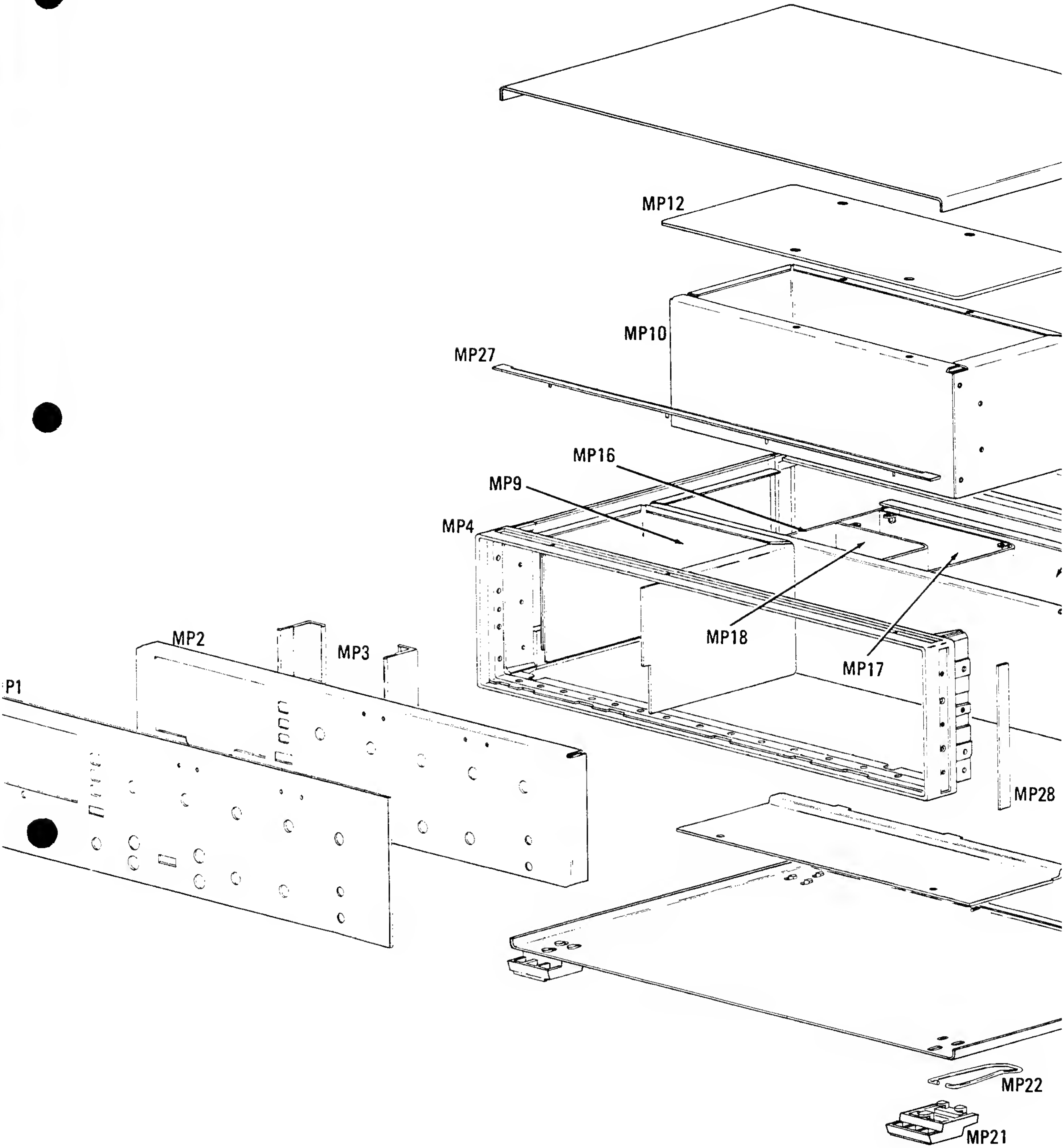
See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W7	00339-61607	1	CABLE ASSEMBLY, AC POWER	28480	00339-61607
W7S10 △	3101-1666	1	SWITCH TGL BASIC DPDT NS 3A 125VAC	28480	3101-1656
	5040-5932	1	COVER, ON POWER SWITCH	28480	5040-5932
W8	00339-61608	1	CABLE ASSEMBLY, FREQUENCY IND.	28480	00339-61608
W9	00339-61609	1	CABLE ASSEMBLY, LEVEL IND.	28480	00339-61609
W10	00339-61610	1	CABLE ASSEMBLY, FREQUENCY VERNIER	28480	00339-61610
	00140-44702	3	SPACERS, FOAM	28480	00140-44702
W10P4	1251-0512	1	HOUSING, CONNECTOR, 5-PIN FEMALE	27264	09-50-7051
	1251-3073		CONTACT, CONNECTOR	27264	08-50-0107
W10R2	2100-3681	1	RESISTOR, VAR SHEG (FREQ. VERNIER)	28480	2100-3681
W11*	8120-2574	6	CABLE ASSEMBLY	28480	8120-2574
W12*	8120-2574		CABLE ASSEMBLY	28480	8120-2574
W13*	8120-2574		CABLE ASSEMBLY	28480	8120-2574
W14*	8120-2574		CABLE ASSEMBLY	28480	8120-2574
W15*	8120-2574		CABLE ASSEMBLY	28480	8120-2574
W16*	8120-2574		CABLE ASSEMBLY	28480	8120-2574
W17*	8120-2575	4	CABLE ASSEMBLY	28480	8120-2575
W18*	8120-2575		CABLE ASSEMBLY	28480	8120-2575
W19*	8120-2575		CABLE ASSEMBLY	28480	8120-2575
W20*	8120-2575		CABLE ASSEMBLY	28480	8120-2575
	0370-2994	1	KNOB, POINTER/HEX, CAP (FUNCTION)	28480	0370-2994
	00339-03701	1	SHAFT, FM	28480	00339-03701
	3030-0690	20	SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	1500-0019		COUPLER-RGD .75-LG BRS	0510M	120
	0370-1099	2	KNOB-BASE-PTR 1/2 JGK .25-IN-ID	28480	0370-1099
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	00339-04001	1	KNOB, DISTORTION RNG	28480	00339-04001
	3130-0533	1	DETENT, 9-POSITION	28480	3130-0533
	00339-04002	1	KNOB, INPUT RNG	28480	00339-04002
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	3130-0534	1	DETENT, 12-POSITION	28480	3130-0534
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	00339-04004	1	KNOB, TENS	28480	00339-04004
	3130-0535	2	DETENT, 10-POSITION	28480	3130-0535
	00339-04005	1	KNOB, UNITS	28480	00339-04005
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	3130-0535		DETENT, 10-POSITION	28480	3130-0535
	00339-04006	1	KNOB, MULTIPLIER	28480	00339-04006
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	3130-0536	1	DETENT, 4-POSITION	28480	3130-0536
	0370-1099		KNOB, POINTER (FREQUENCY VERNIER)	28480	0370-1099
	00339-03702	1	SHAFT, NON-METALIC	28480	00339-03702
	1500-0019		COUPLER-RGD .75-LG BRS	0510M	120
		1			
	00339-04003	1	KNOB, OSC. LEVEL	28480	00339-04003
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	0370-2990	10	KNOB, RND W/BAR	28480	0370-2990
	3030-0690		SCREW-SET 4-40 .13-IN-LG SMALL CUP-PT	28480	3030-0690
	0370-1125	1	KNOB, POINTER (LEVEL VERNIER)	28480	0370-1125
	3030-0051	2	SCREW-SET 4-40 .094-IN-LG SMALL CUP-PT	28480	3030-0051
XF1	2110-0465	1	CAP, FUSEHOLDER	28480	2110-0465
	2110-0467	1	NUT, HEX SINGLE CHAMFER 1/2-28 THREAD	75915	903-070
	2110-0473	1	FUSEHOLDER-EXTR POST 20A 500V UL/IEC	04706	3-H003-010

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MECHANICAL PARTS		
MP1	00339-00201	1	PANEL, FRONT	28480	00339-00201
MP2	00339-00202	1	FRONT SUB-PANEL	28480	00339-00202
MP3	00741-01212	2	BRACKET, METER	28480	00741-01212
MP4	5020-8803	1	FRONT FRAME	28480	5020-8803
MP5	5020-8835	4	CORNER, STRUT	28480	5020-8835
MP6	00339-01206	1	BRACKET, SHIELD MOUNTING	28480	00339-01206
	5040-4258	8	FASTENER, CAPTIVE	28480	5040-4258
MP7	5020-8804	1	REAR, CASTING	28480	5020-8804
MP8	00339-00203	1	PANEL, REAR	28480	00339-00203
MP9	00339-00603	1	SHIELD, DETECTOR	28480	00339-00603
	0403-0123	1	GUIDE-PC BOARD GRN POLYC .062-BD-THKNS	28480	0403-0123
	5040-4503	6	FASTENER, CAPTIVE	28480	5040-4503
MP10	00339-00601	1	SHIELD, OSC., FRONT	28480	00339-00601
MP11	00339-00602	1	SHIELD, OSC., BACK	28480	00339-00602
	5040-4503		FASTENER, CAPTIVE	28480	5040-4503
MP12	00339-04102	1	PLATE, OSC, TOP	28480	00339-04102
MP13	00339-04101	1	PLATE, OSC, BOTTOM	28480	00339-04101
MP14	00339-00604	1	SHIELD-P.S., FRONT	28480	00339-00604
MP15	00339-00605	1	SHIELD, P.S., BACK	28480	00339-00605
	0403-0156	2	GUIDE-PC BOARD YEL POLYC .062-BD-THKNS	28480	0403-0156
	5040-4258		FASTENER, CAPTIVE	28480	5040-4258
MP16	00339-00606	1	SHIELD, P.S.	28480	00339-00606
	0403-0156		GUIDE-PC BOARD YEL POLYC .062-BD-THKNS	28480	0403-0156
MP17	00339-00607	1	SHIELD, INPUT AMPLIFIER	28480	00339-00607
MP18	00339-00608	1	SHIELD, ATTENUATOR	28480	00339-00608
MP19	5060-9833	1	COVER, TOP (STANDARD)	28480	5060-9833
MP20	5060-9845	1	COVER, BOTTOM (STANDARD)	28480	5060-9845
MP21	5040-7201	4	FOOT(STANDARD)	28480	5040-7201
MP22	1460-1345	2	TILT STAND SST	28480	1460-1345
MP23	5060-9878	2	COVER, SIDE (STANDARD)	28480	5060-9878
MP24	5060-9802	2	HANDLE, STRAP	28480	5060-9802
MP25	5040-7219	2	STRAP, HANDLE, CAP-FRONT	28480	5040-7219
MP26	5040-7220	2	STRAP, HANDLE, CAP-REAR	28480	5040-7220
MP27	5040-7202	1	TRIM, TOP	28480	5040-7202
MP28	5001-0439	2	SIDE TRIM	28480	5001-0439
MP29	00339-00609	1	TRANSFORMER SHIELD	28480	00339-00609


MP12
MP10
MP27
MP16
MP9
MP4
MP18
MP17
MP2
MP3
P1
MP28
MP22
MP21

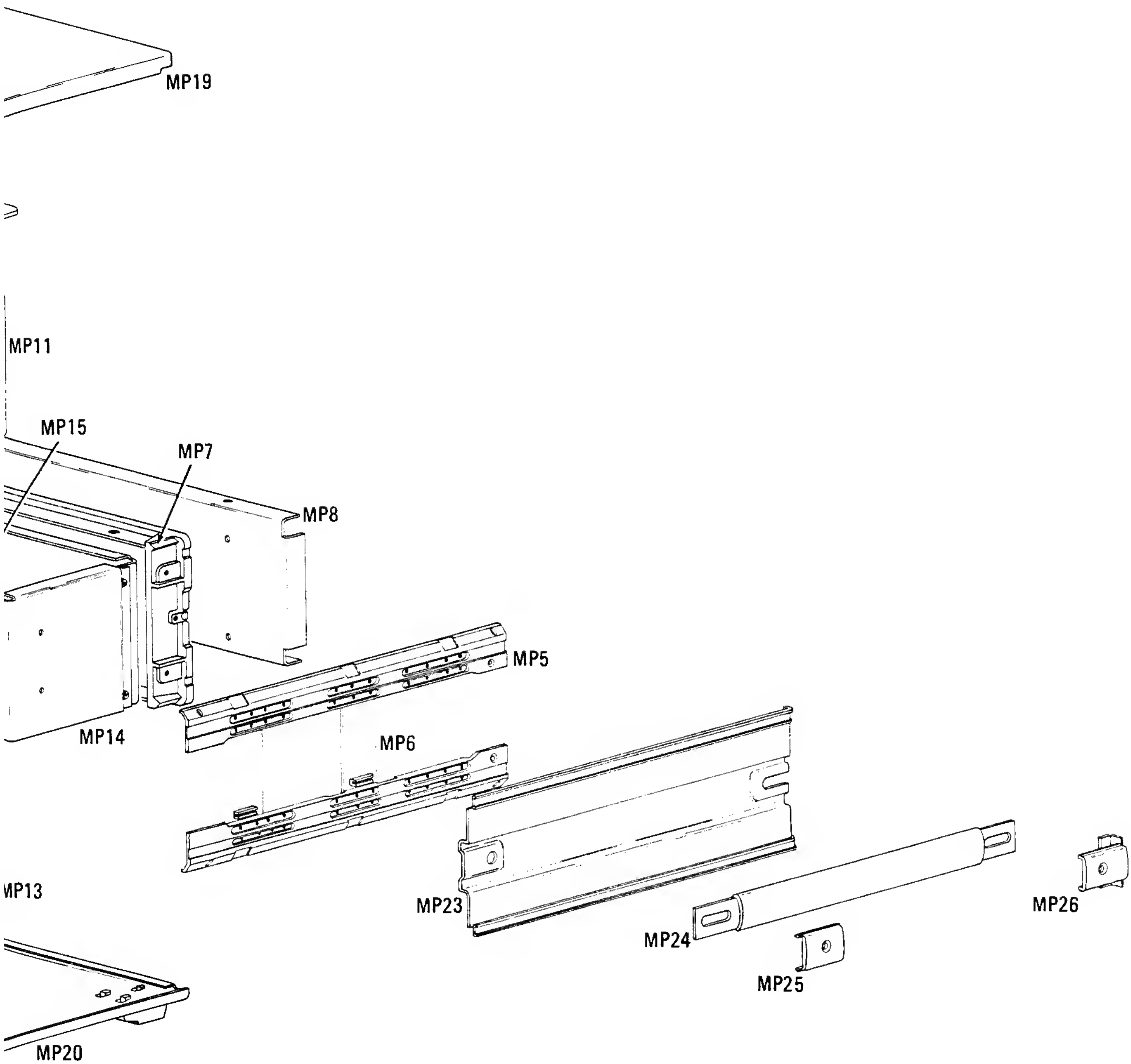


Figure 6-1. Mechanical Parts Locator.

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION.

7-2. This section contains information necessary to adapt this manual to instruments with serial numbers lower than the number listed on the title page.

7-3. MANUAL CHANGES.

7-4. To adapt this manual to your instrument, refer to Table 7-1 and make the manual changes listed opposite your instrument serial number. These changes should be performed in the sequence listed.

7-5. If your instrument serial number is not listed on the title page of this manual or in Table 7-1, it may be documented in a yellow MANUAL CHANGES supplement included with the manual. For additional information, refer to INSTRUMENT AND MANUAL IDENTIFICATION in Section I.

Table 7-1. Manual Changes by Serial Number.

Instrument Serial No.	Make Manual Change
1730A00101 to 1730A00266	A

7-6. MANUAL CHANGE INSTRUCTIONS.

CHANGE A

The oscillator circuitry was simplified beginning with instrument serial number 1730A00266. To adapt this manual to prior instruments make the following changes.

Page 6-3, Table 6-3.

Add:
A1C20, 0180-0291, Cap-Fxd 1 μF $\pm$10% 35 VDC TA
A1CR1, 1901-0518, Diode-Schottky
A1Q1, 1855-0360, Transistor Mosfet N-Chan D-Mode
A1R32, R33, 0698-7332, Resistor 1 M 1% .125 W F TC=0$\pm$100
Delete:
A1CR14, 1901-0040, Diode-Switching 30 V 5 mA

Page 8-21/8-22, Figure 8-17.

Change:
Modify the amplitude control circuitry as shown in Figure 7-1.

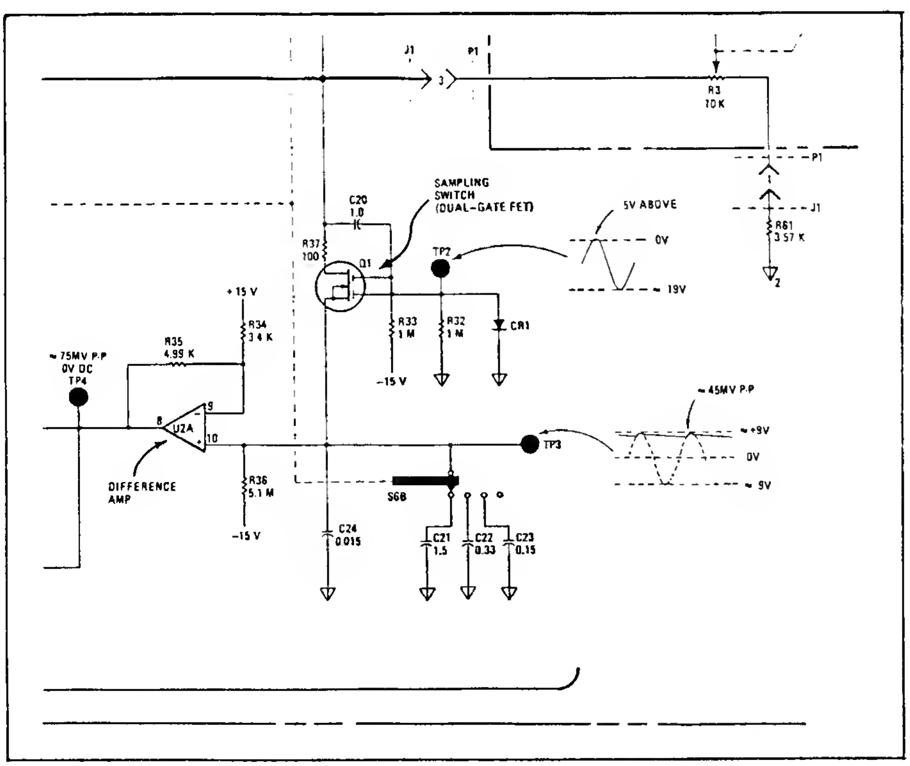


Figure 7-1. Amplitude Control Circuit Change.

SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This section contains theory of operation, troubleshooting information, safety considerations, and general service information for the Model 339A Distortion Measurement Set.

8-3. SAFETY CONSIDERATIONS.

8-4. Although this instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to maintain the instrument in safe operating condition. Service and adjustments should be performed only by qualified service personnel.

8-5. Any adjustment, maintenance, and repair of the opened instrument while any power or voltage is applied should be avoided as much as possible, and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

WARNING

Any interruption of the protective grounding conductor (inside or outside the instrument) or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption of the protective grounding conductor is strictly prohibited.

8-6. It is possible for capacitors inside the instrument to still be charged even if the instrument has been disconnected from its power source.

8-7. Be certain that only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

WARNING

The service information presented in this manual is normally used with the protective covers removed and power applied to the instrument. Energy available at many points may, if contacted, result in personal injury.

8-8. RECOMMENDED TEST EQUIPMENT.

8-9. Test equipment required to maintain the Distortion Measurement Set is listed in Table 1-3. Equipment other than that listed may be used if it meets the critical specifications.

THEORY OF OPERATION

8-10. GENERAL DESCRIPTION.

8-11. Figure 8-1 shows a simplified block diagram of the Model 339A Distortion Measurement Set. The 339A combines an automatic, high resolution distortion analyzer/voltmeter and a low distortion oscillator to provide a drive signal to the device under test. The frequency of both the oscillator and the fundamental rejection circuit (notch filter) of the distortion analyzer are tuned simultaneously to simplify operation.

8-12. The Model 339A features an AM DETECTOR input, in addition to the normal analyzer/voltmeter input, which permits the user to measure the distortion of a modulating signal on an RF carrier. Selection of the AM DETECTOR input or DIStortion ANalyzer input is made by a front panel switch.

8-13. An OSCILLATOR LEVEL function is provided to allow the operator to monitor the oscillator output level without connecting external cables.

8-14. The selected input signal is applied to the input attenuator/amplifier which provides the proper amount of attenuation or gain required to place the signal within the input range of the analyzer circuits.

8-15. The Fundamental Rejection Circuit consists of a "bridged T" filter network in conjunction with a "notch amplifier" and feed-back amplifier which enhance the rejection characteristics. The "nulling" process of the circuit is fully automatic to simplify operation and to provide maximum accuracy. If the fundamental frequency of the input signal is not within the "pull-in" range of the rejection circuit (in cases where an external signal source is used), a front panel LED indicator is lit to indicate which direction to turn the FREQUENCY controls to bring the rejection circuit within range. The

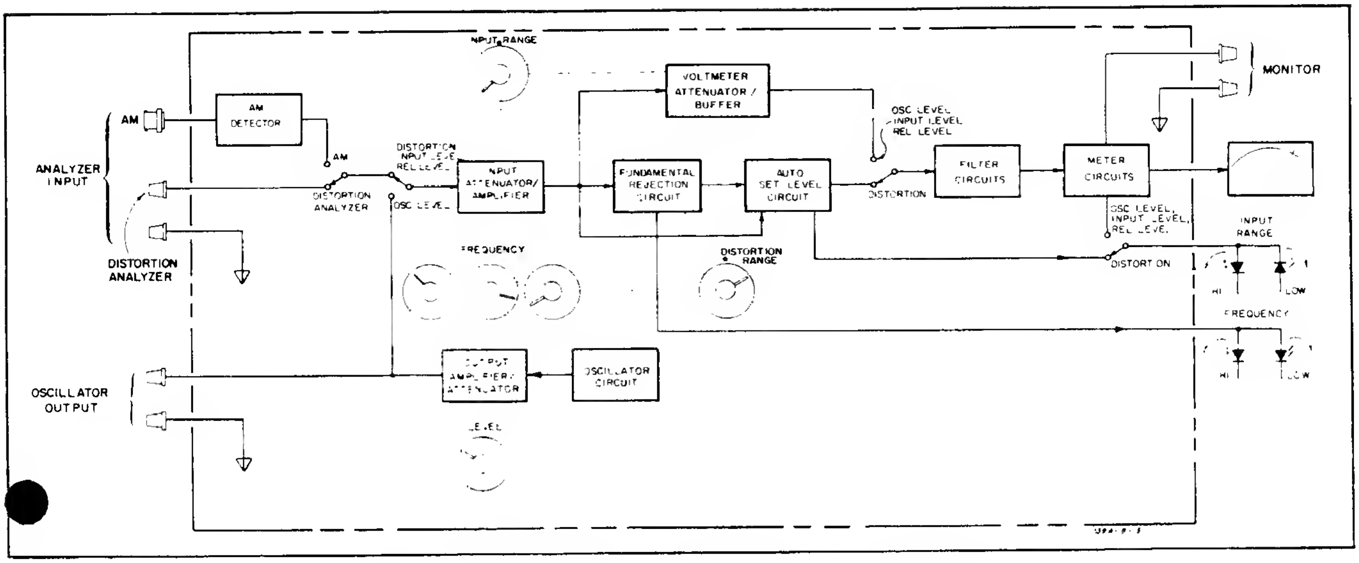


Figure 8-1. Model 339A Simplified Block Diagram.

rejection circuit attenuates the fundamental frequency of the input signal approximately -100 dB. The distortion signal (output signal) of the rejection circuit is attenuated or amplified (depending upon the setting of the DISTORTION RANGE control) by the distortion amplifier and applied to the input of the Auto Set-Level circuit.

8-16. The Automatic Set-Level Circuit, as the name implies, automatically adjust the distortion signal to provide a distortion measurement which is relative to a full-scale input level. The Auto Set-Level circuit eliminates the necessity of manually setting a reference level before making a distortion measurement.

8-17. When using the voltmeter function of the 339A, (OSCillator LEVEL, INPUT LEVEL, and RELative LEVEL), the Voltmeter Attenuator Buffer supplies the necessary amount of attenuation to bring the input signal within the input range of the meter circuits and provides isolation between the input amplifier and meter circuits.

8-18. The Filter Circuits, included with the Model 339A, are three-pole active filters and include a 400 Hz high-pass filter, a 30 kHz low-pass filter, and an 80 kHz low-pass filter. These filters may be selected individually or in any combination to provide the filter characteristics required.

8-19. The Meter Circuits include an input amplifier, and RMS detector, a variable gain amplifier, and a voltage to current converter. The input amplifier amplifies the input signal by +40 dB to drive the rms detector and supply an output signal to the MONITOR terminals. The full-scale output of this amplifier is 1 V rms. The rms detector converts the input signal to a dc voltage proportional to the rms value of the input (1 V dc full-scale). The output of the rms detector is applied to the input of a variable gain amplifier which acts as a buffer in all functions except RELative LEVEL. In this function, the variable gain amplifier is enabled to permit the user to set a convenient reference level on the meter. The output of the variable gain amplifier is applied to both the voltage-to-current converter which drives the meter and the input range comparators. These comparators are used to light front panel LED indicators when the meter drive signal is greater than full-scale or less than 1/3 full-scale. The LEDs indicate which direction to turn the INPUT RANGE control to bring the drive signal within the range of the meter.

8-20. The Oscillator Circuit of the 339A uses a "bridged T" filter network to determine the operating frequency and employs a sampling feedback circuit to control the oscillator output level. The amplitude feedback circuit is designed to provide cycle-to-cycle amplitude control while minimizing distortion caused by regulating the output level.

8-21. The Output Amplifier/Attenuator circuit of the oscillator provides isolation between the oscillator circuit and the output terminals and varies the output level from 1 mV rms to greater than 3 V rms into a 600 ohm load.

8-22. CIRCUIT DESCRIPTIONS.

8-23. Input Circuitry.

8-24. The front panel FUNCTION switch permits the user to select one of four input functions, as follows:

OSCillator LEVEL - In this function the meter circuit monitors the rms output level of the oscillator.

DISTORTION - The distortion function measures the rms value of total harmonic distortion (THD) of the input signal.

INPUT LEVEL — In this function, the meter

indicates the rms value of the input signal (voltmeter function).

RELATIVE LEVEL - The relative level function permits the user to measure the rms value of the input signal relative to a pre-set reference (dB and VU measurements).

8-25. In addition to the DIStortion ANalyzer input, the 339A also includes an AM DETECTOR INPUT which detects the AM modulation signal of an RF carrier. This allows the user to measure the total harmonic distortion of the modulation signal.

8-26. Input Amplifier.

8-27. The 339A input amplifier is an operational amplifier circuit which uses a combination of attenuation and gain to limit the full-scale output of the amplifier to 3 V rms. Figure 8-2 shows a simplified schematic of the input amplifier and lists the attenuation and gain for each INPUT RANGE setting. The output signal of the buffer amplifier is applied to the fundamental rejection circuit (notch filter) and auto set-level circuit of the analyzer section. The voltmeter attenuator provides the necessary attenuation to maintain a 10 mV rms full-scale output signal to the voltmeter buffer amplifier.

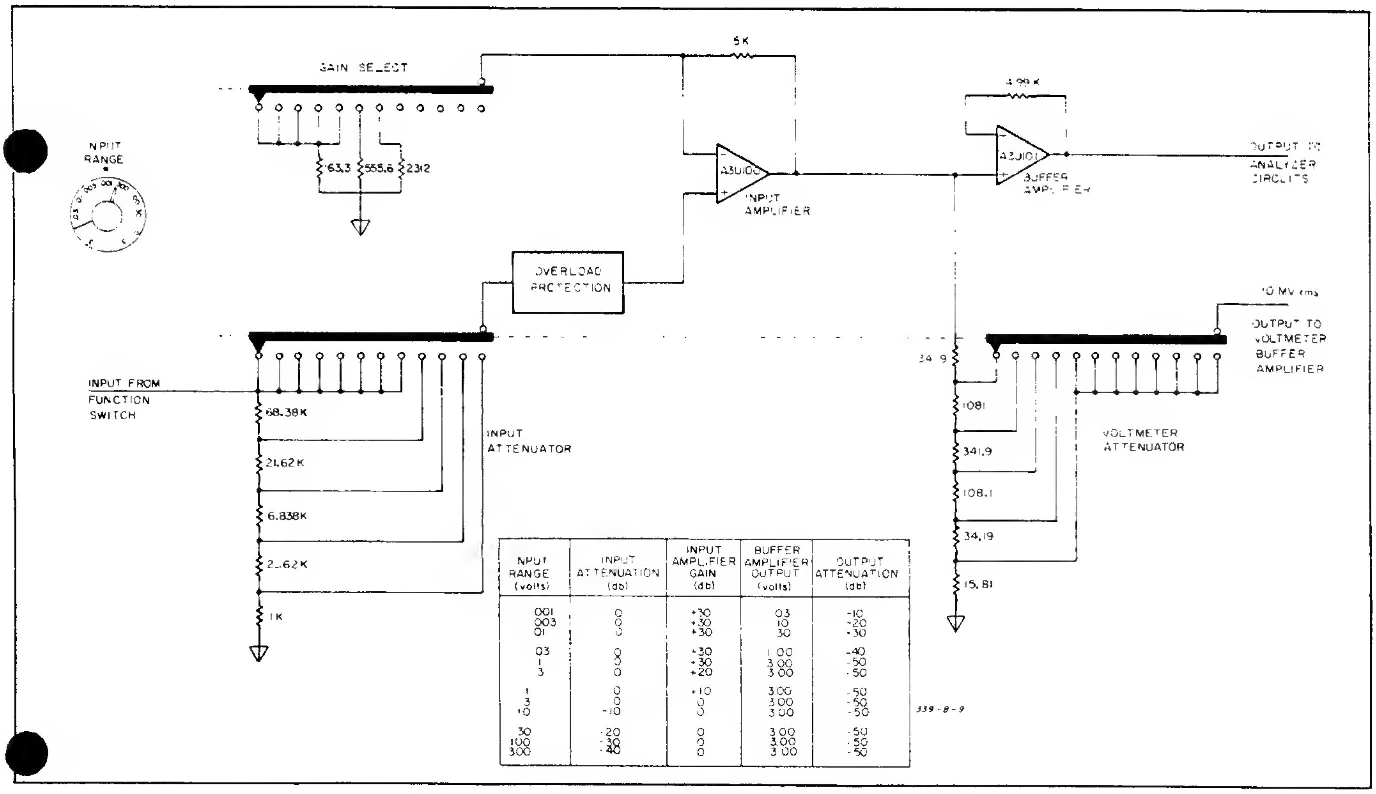
8-28. Input Overload Protection.

8-29. The input amplifier is protected from the application of high voltage to the input by a zener referenced protection circuit which limits the input voltage to approximately 11 volts peak. The input is further protected by a fuse which limits the input current to approximately 60 mA. During normal operation, FET A3Q100 supplies a feedback signal which is equal in phase and amplitude to the input signal to eliminate leakage caused by the capacitance of the protection diodes.

8-30. Analyzer Circuitry.

8-31. Notch Filter.

8-32. The purpose of the Notch Filter is to eliminate the fundamental frequency of the signal being measured. The basic notch filter circuit, as shown in Figure 8-3, is a "bridged T" RC filter network. The filter is tuned to approximately the fundamental frequency of the input signal by the front panel FREQUENCY controls and is fine tuned to the exact frequency by the phase control circuit. The notch filter by itself attenuates the fundamental frequency only about -16 dB. To improve the "notch" characteristics, a portion of the input signal is "fed-forward" and algebraically summed with the output of the notch filter by notch amplifier A3U3. The Application of the feed-forward signal cancels the remaining fundamental signal. The correct level of feed-forward signal necessary to cancel the fundamental frequency is regulated by the amplitude control circuit. The combination of feed-forward signal and the automatic frequency tuning provided by the phase control circuit improves the "notch depth" to



INPUT RANGE (volts)	INPUT ATTENUATION (db)	INPUT AMPLIFIER GAIN (db)	BUFFER AMPLIFIER OUTPUT (volts)	OUTPUT ATTENUATION (db)
001	0	+30	03	-10
003	0	+30	10	-20
01	0	+30	30	-30
03	0	+30	1 00	-40
1	0	+30	3 00	-50
3	0	+20	3 00	-50
1	0	+10	3.00	-50
3	0	0	3 00	-50
10	-10	0	3 00	-50
30	-20	0	3 00	-50
100	-30	0	3.00	-50
300	-40	0	3 00	-50

Figure 8-2. Simplified Input Amplifier Schematic.

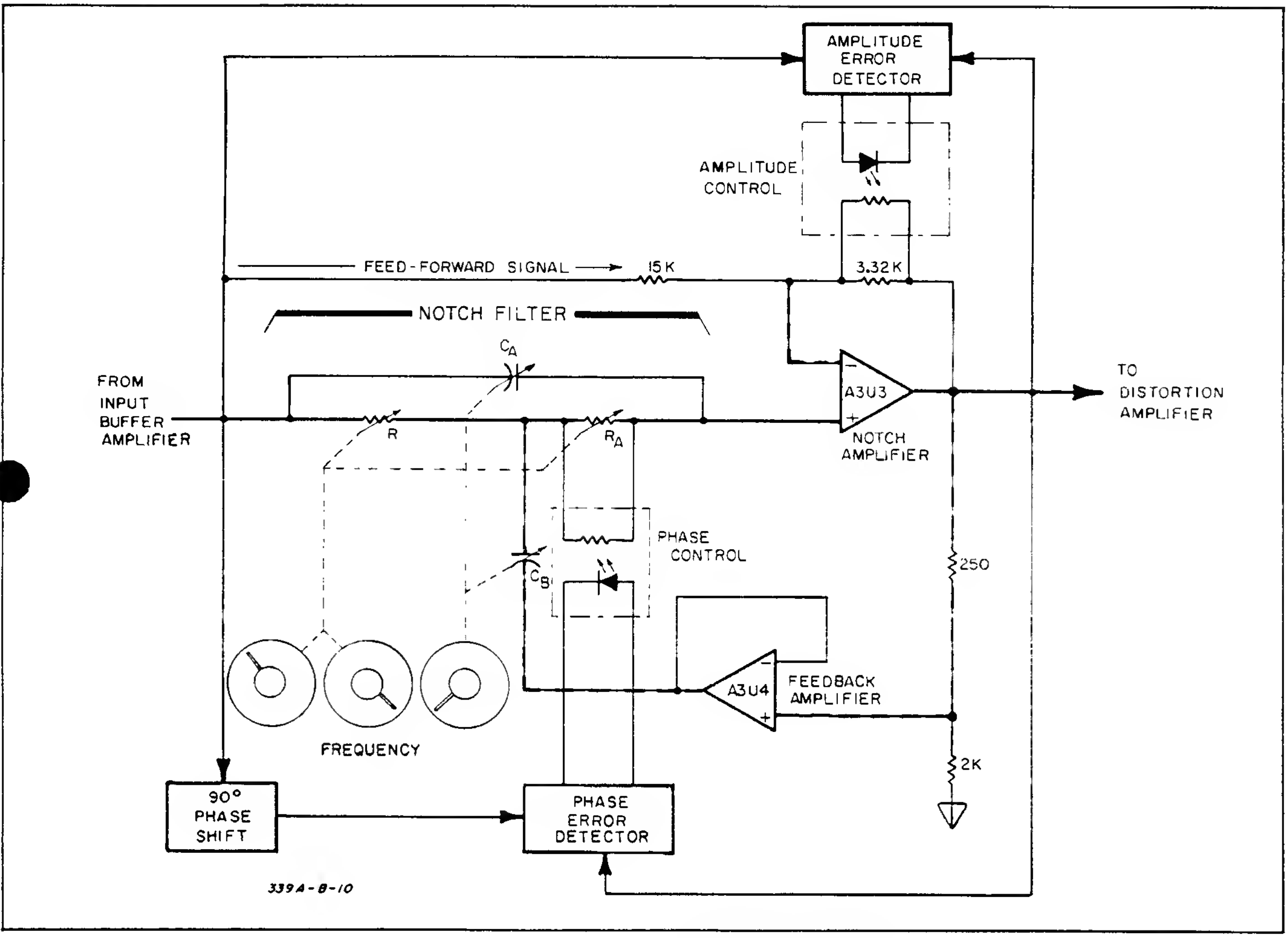


Figure 8-3. Simplified Notch Filter Schematic.

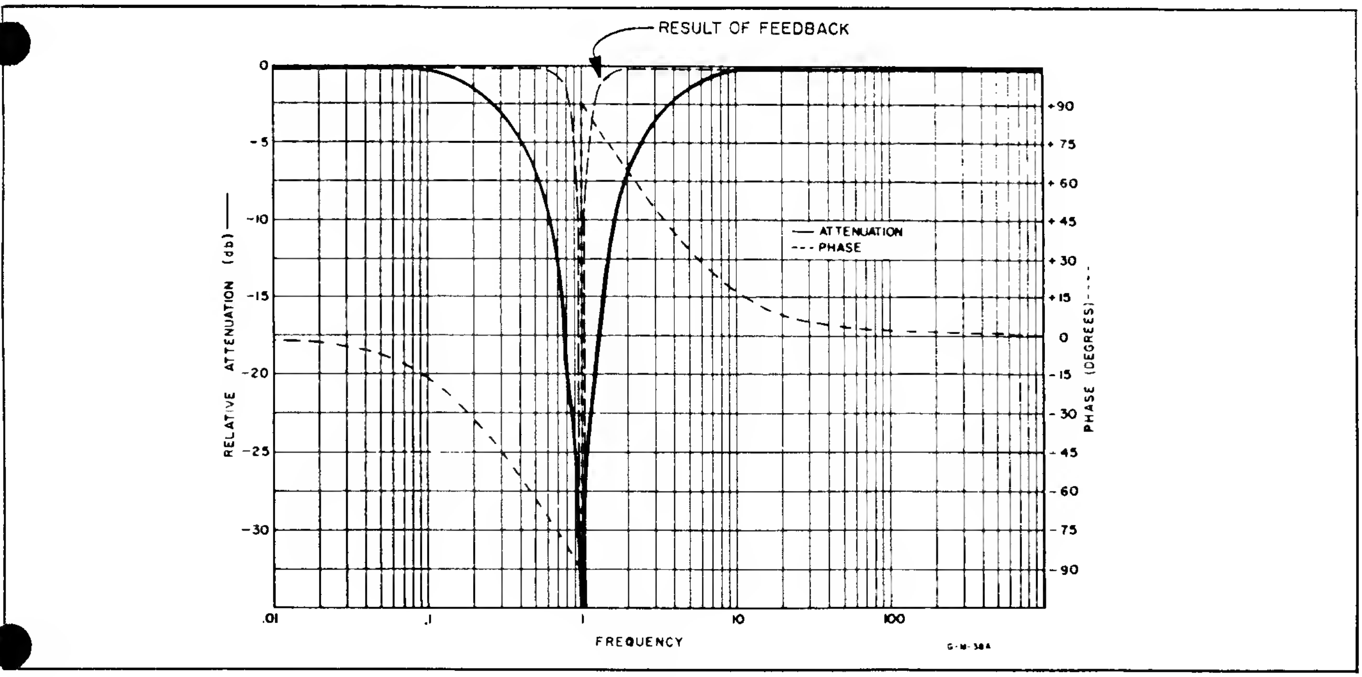


Figure 8-4. Effect of Feedback.

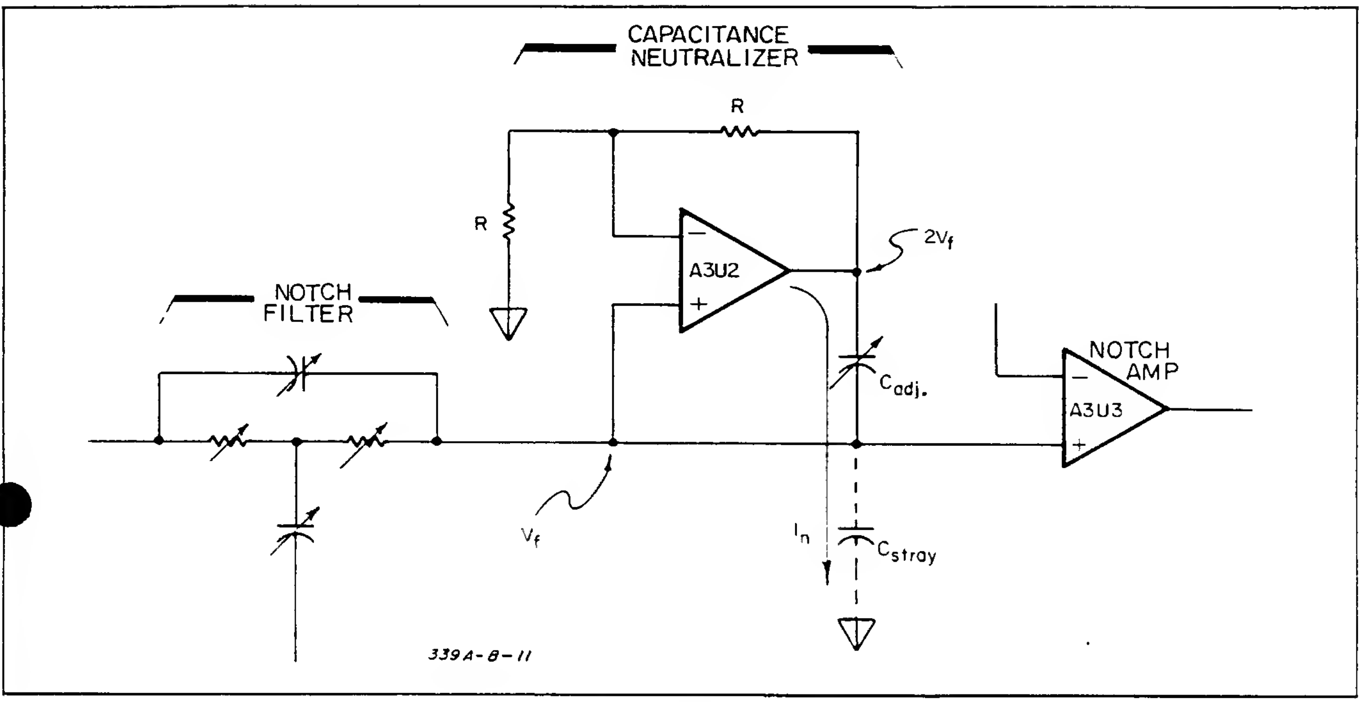


Figure 8-5. Simplified Capacitance Neutralizer Schematic.

approximately -100 dB. To improve the "notch width", a portion of the output signal from A3U3 is fed-back to the notch filter circuit. The effects of this feed-back are illustrated in Figure 8-4. Feed-back amplifier A3U4 is a unity gain amplifier which provides isolation between notch amplifier A3U3 and the notch filter circuitry. The notch filter output (from A3U3) is applied to the input of distortion amplifier A3U200 and to the input of the amplitude and phase error detector circuits.

8-33. Capacitance Neutralizer.

8-34. The purpose of the Capacitance Neutralizer is to neutralize the effects of stray capacitance at the output of the notch filter. The neutralizer circuit (shown in Figure 8-5) consists of an operational amplifier whose gain is set by resistors "R". The output voltage of A3U2 is equal to: Vf (1 + R/R) or 2Vf, where Vf is the output voltage from the notch filter. The output of A3U2 drives

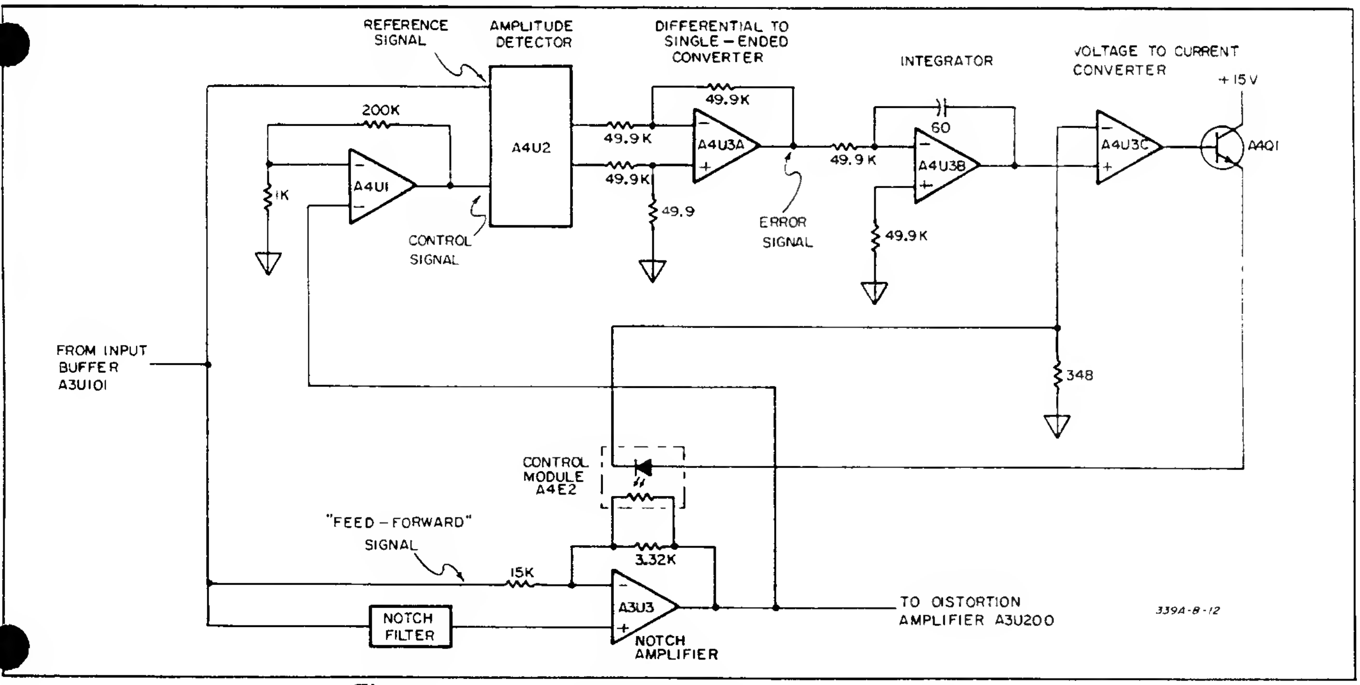


Figure 8-6. Simplified Amplitude Error Detector Schematic.

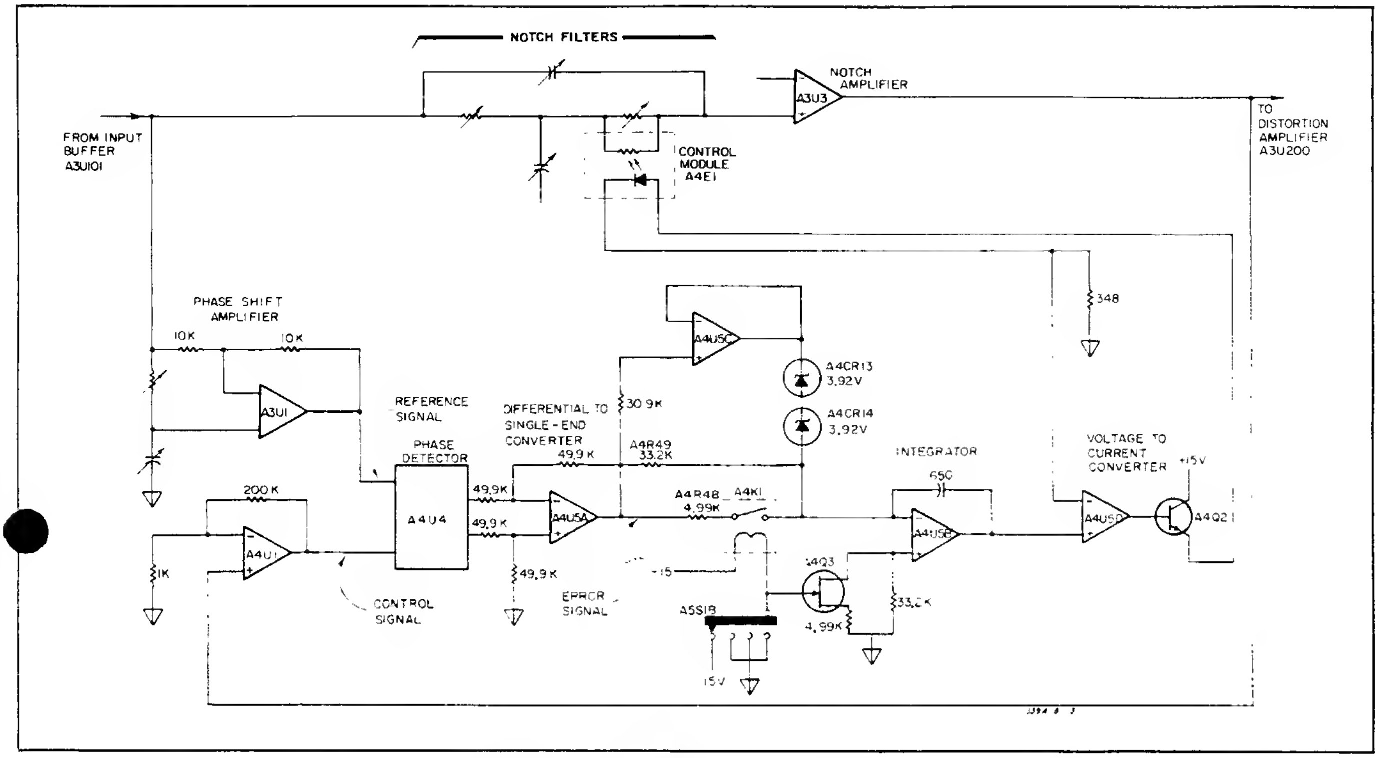


Figure 8-7. Simplified Phase Error Detector Schematic.

capacitors C_{adj} and C_{stray}. C_{adj} is adjusted to be equal to C_{stray} so that 1/2 of the output of A3U2 (a voltage = V_f) is dropped across each. Since the current necessary to drive the stray capacitance (C_{stray}) is supplied by the neutralizer circuit, the output of the notch filter is not loaded.

8-35. Amplitude Error Detector.

8-36. The purpose of the Amplitude Error Detector is to regulate the amount of "feed-forward" signal required to optimize the depth of the notch filter. Figure 8-6 shows a simplified schematic of the amplitude error detector circuit. The input signal to the notch filter (from input buffer amplifier A3U101) is used as the reference signal for amplitude detector A4U2. The output of the notch amplifier (A3U3) is amplified by A4U1 and is used as the control signal to A4U2. Amplifier A4U1 supplies a gain of 200, which is necessary to achieve "notch depths" in excess of -100 dB. The output of amplitude detector A4U2 is the product of the two input signals. Mathematically, the output of A4U2 (V_o) is equal to the reference signal ($A_1 \cos wt$) times the control signal ($A_2 \cos wt + \phi$), or $V_o = A_1A_2 [(\cos wt + \phi)]$. By trig identity, this expression is equal to:

$$V_o = 1/2\ A_1A_2 [\cos (2\ wt + \phi) + \cos \phi].$$

The differential output of A4U2 is converted to a single ended output by A4U3A and applied to the integrator. The integrator (A4U3B) acts as a low-pass filter to the output signal from the amplitude detector and responds only to the low frequency component of the signal. The error signal is, therefore, effectively equal to:

$$V_o = 1/2\ A_1A_2 \cos \phi \text{ times a constant "K".}$$

Since the notch filter is tuned to the fundamental frequency of the input signal, the phase difference term of the error signal ($\cos \phi$) is equal to 1 ($\cos 0° = 1$). The error signal as seen by the integrator, is therefore a dc voltage equal to:

$$K \frac{(A_1A_2)}{2}.$$

Since the amplitude of the reference signal (A_1) is held constant, any changes in the error signal are caused by the amplitude changes of the control signal (A_2). The error signal to the integrator can therefore be expressed as:

$$V_o = A_2 \frac{(KA_1)}{2}.$$

The output of the integrator is applied to a voltage-to-current converter (A4U3C and A3Q1) which drives amplitude control module A3E2. Control module A3E2 adjusts the gain of notch amplifier A3U3 to provide the proper amount of feed-forward signal necessary to cancel the fundamental frequency at the output of the notch amplifier and therefore reduce the error signal to zero.

8-37. Phase Error Detector.

8-38. The purpose of the Phase Error Detector circuit is to "fine tune" the notch filter to the fundamental frequency of the input signal. The circuit shown in Figure 8-7 is a simplified schematic of the phase detector circuit.

The input signal from input buffer amplifier A3U101 is retarded 90° by phase shift amplifier A3U1 and applied to the input of A4U4 as the reference signal. The output of the notch amplifier (A3U3) is amplified by A4U1 and is used by the phase detector (A4U4) as the control signal. The output of the error detector is equal to the product of the two input signals. Mathematically, the output of A4U4 (V_o) is equal to the reference signal [A_1 Cos (wt - 90°)] times the control signal (A_2 Cos wt + ϕ) or, $V_o = A_1A_2$ [(Cos wt -90°) (Cos wt + ϕ)]. By trig identity, this expression is equal to:

$$[\text{Cos}\ (2\ wt + \phi - 90^\circ) + \text{Cos}\ (\phi + 90^\circ)] \text{ or; } V_o = 1/2\ A_1A_2\ [\sin\ (2\ wt + \phi) - \sin\ o]$$

The differential output of A4U4 is converted to a single-ended output by A4U5A and applied to the integrator. The integrator (A4U5B) acts as a low-pass filter to the output signal from the phase detector and responds only to the low frequency component of the signal. The error signal is, therefore, effectively equal to:

$$V_o = 1/2\ A_1A_2 \sin \phi \text{ times a constant "K".}$$

The amplitude and phase of the reference signal (A_1 Cos - 90°) is held constant. Therefore, the error signal (V_o) is zero only when the phase difference between the reference signal and control signal is equal to 90° (Cos 90° = 0). Since the reference signal has purposely been shifted by 90°, this condition can only occur when the notch filter is perfectly "tuned", resulting in 0° phase shift of the signal through it. The error signal from the output of A4U5A is applied to the input circuit of the integrator. Resistors A4R48 and A4R49 determine the time constant of integrator A4U5B. On the X10 frequency range (10 Hz -100 Hz) relay A4K1 opens to increase the time constant. The time constant is increased on this range to prevent distortion which might be caused by the phase control circuit at low frequencies. On frequency ranges X100 through X10 K (100 Hz - 110 kHz), relay A4K1 is closed to parallel A4R49 with A4R48 to reduce the time constant FET switch A4Q3 switches the integrator bias resistance to prevent offsets at the output caused by input imbalance. Amplifier A4U5C and diodes A4CR13 and A4CR14 provide a "fast-charge" path for the integrator when the notch filter is extremely off frequency. In this case, the output of A4U5A exceeds the break-down voltage of A4CR13 or A4CR14 to provide increased charge current to the integrator. As the notch filter approaches the proper frequency, the output of A4U5A no longer exceeds the break-down voltage of A4CR13 or A4CR14 and normal operation resumes. The output of integrator A4U5B is applied to the voltage-to-current converter (A4U5D) and A4Q2) which drives phase control module A3E1. Control module A3E1 changes the resonant frequency of the notch filter.

8-39. Auto Set-Level Circuit.

8-40. The Auto Set-Level circuit automatically adjusts the gain of the distortion analyzer circuitry to provide a full-scale reference level for distortion measurements. Figure 8-8 shows a simplified schematic of the auto setlevel circuit used in the Model 339A. The input signal from amplifier A3U101 is applied to the input of rms detector A2U7. The output of A2U7 is a dc voltage equivalent to the rms value of the input signal. This signal is applied to control amplifier A2U8D whose output is connected to one end of a resistive summing network. The other end of the summing network is referenced to -15 V dc. The output of the summing network is applied to the input of integrator A2U8B which drives photomodule A2E1. Photo-module A2E1 consists of an LED driver and two balanced, photo-sensitive resistors which are part of the gain determining circuits of control amplifier A2U8D and set-level amplifier A2U10. Integrator A2U8B drives the photo-module until the gain of control amplifier A2U8D is such that its output is equal to a full-scale input level (3.162 V dc). At this point, the output of the summing network is zero and the circuit is stable. Since the set-level amplifier and control amplifier circuits are identical, the gain of set-level amplifier A2U10 is equal to that established by control amplifier A2U3D. Therefore, the set-level amplifier amplifies the distortion signal by the amount f gain which would be required to give a full-scale meter reading of the input signal or, the distortion signal is referenced to a full-scale input level.

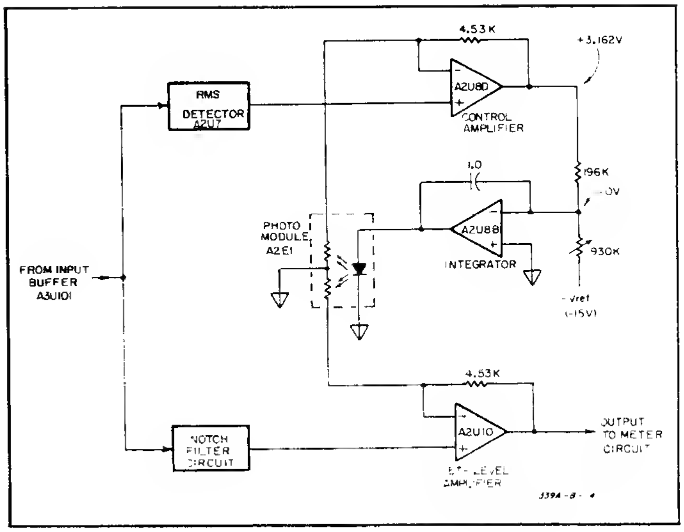


Figure 8-8. Simplified Auto Set-Level Circuit.

8-41. Meter Circuits.

8-42. Figure 8-9 shows a simplified schematic of the meter circuitry used in the Model 339A. The voltmeter input shown includes the OSCillator LEVEL, INPUT LEVEL, and RELative LEVEL input functions. The distortion input is the distortion signal from the analyzer circuitry. The input signal to the meter circuitry may be filtered to remove unwanted frequencies and noise. The filters are three-pole active filters and include a 400 Hz high-pass filter and 30 kHz and 80 kHz low-pass filter. The signal from the filter circuits is amplified 40 dB by

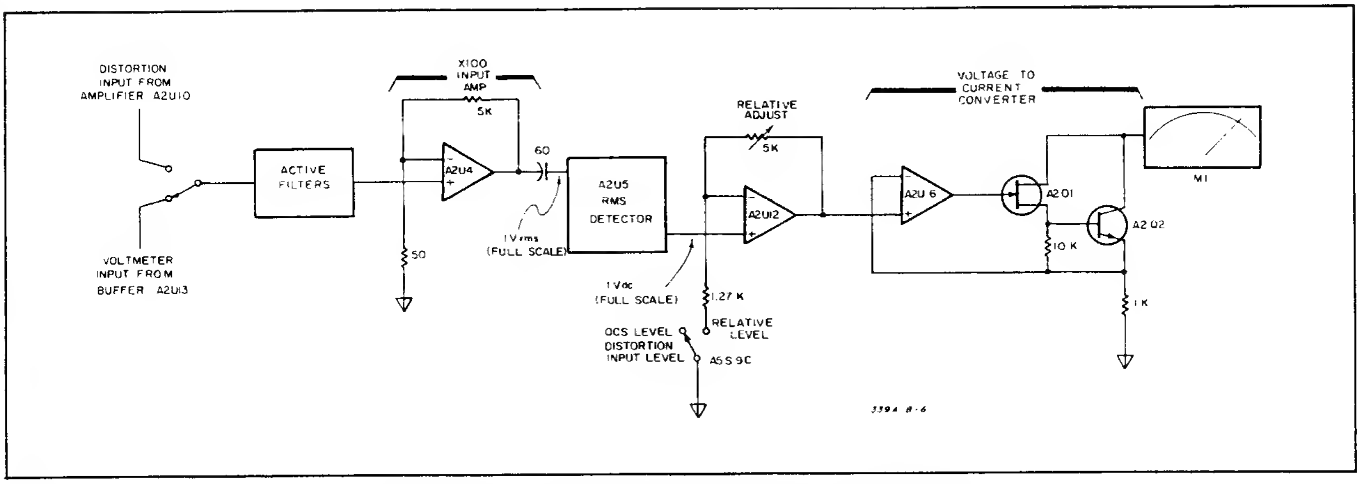


Figure 8-9. Simplified Meter Circuit Schematic.

input amplifier A2U4 to provide a 1 V rms (full-scale) input signal to the RMS detector A2U5. The dc output of the RMS detector is applied to the input of the relative adjust amplifier A2U12 which, in all function except RELative LEVEL, acts as a X1 buffer amplifier. In the RELative LEVEL function, the feed-back path of A2U1 is completed by switch A5S9C to allow the gain of A2U1 to be varied. This permits the user to set a reference level on the meter. The output of the relative adjust amplifier is applied to a voltage-to-current converter (A2U6, A2Q1, and A2Q2) to drive meter M1. Full-scale output current is 1 mA.

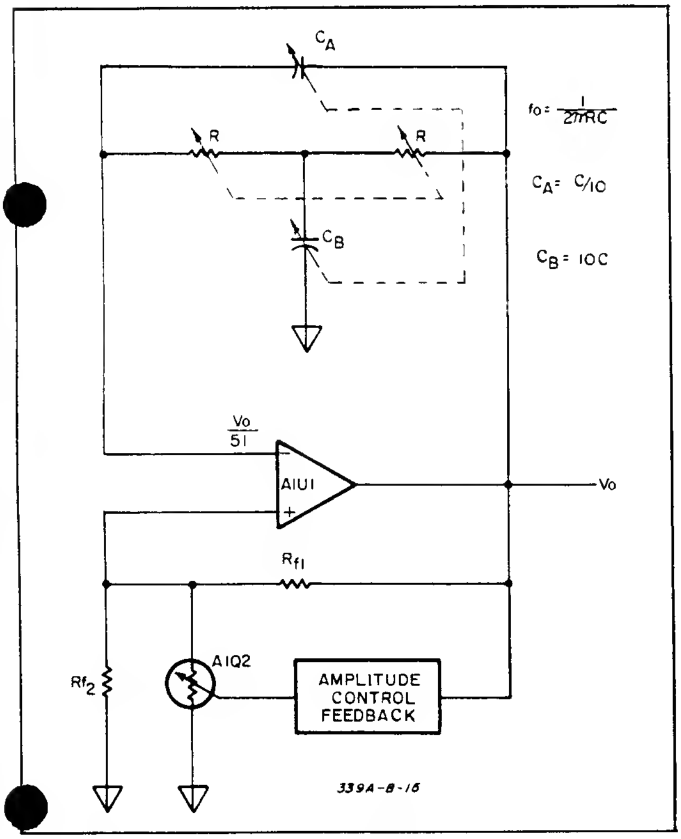


Figure 8-10. Simplified Oscillator Circuit.

8-43. Oscillator Circuit.

8-44. Frequency Generation. Figure 8-10 shows a simplified schematic diagram of the oscillator circuitry used in the Model 339A. The operating frequency of the circuit is determined by a "bridged T" filter network in the negative feed-back path of amplifier A1U1. At resonant frequency, the filter network is at maximum impedance and the negative feed-back to amplifier A1U1 is minimum. The frequency range of the oscillator circuit is determined by the selection of capacitors Ca and Cb while the particular operating frequency is controlled by the selection of resistors R.

8-45. Amplitude Control. The basic oscillator output level is determined by positive feed-back resistors Rf1 and Rf2 and is regulated by the amplitude control circuitry shown in Figure 8-11. The purpose of the amplitude control circuitry is to monitor the oscillator output level and derive an error signal to control the gain of amplifier A1U1. The oscillator output is sampled during the positive peaks by the peak detector circuit which stores a charge equal to the peak amplitude of the output signal on capacitor Ch. The charge on Ch is compared to a reference voltage by difference amplifier A1U2A. The output of A1U2A represents the instantaneous amplitude error of the oscillator signal. This signal is applied to integrator A1U2B and through the fast response bypass circuit to summing amplifier A1U2C. The output of the integrator (A1U2B) represents the average or long-term amplitude error while the signal from the fast response bypass circuit represents the amplitude error on a cycle-to-cycle basis. These two signals are added by summing amplifier A1U2C. The resulting output of A1U2C drives control FET A1Q2 which acts as a variable resistor in parallel with feed-back resistor Rf2 to adjust the gain of oscillator amplifier A1U1.

8-46. Output Buffer and Attenuator. The oscillator signal is applied to the output buffer amplifier (A1U3) through the output LEVEL VERNIER control. The level vernier varies the output level of the buffer amplifier from approximately 6.5 V rms to 1.8 V rms. The output of the buffer amplifier is divided by the output attenuator in 10 dB V steps from 3 V rms full-scale to 3 mV rms full-scale into a 600 ohm load. The attenuator also includes an OFF position which disables the oscillator output and terminates the OUTPUT terminals with a 600 ohm resistive load. The combination of the output attenuator and level vernier permit the selection of output levels from 1 mV rms to greater-than 3 V rms into 600 ohms. The oscillator output level may be monitored on the meter when the OSCillator LEVEL function is selected. A zener diode protection circuit protects the oscillator circuitry from the accidental application of voltage to the oscillator OUTPUT terminals.

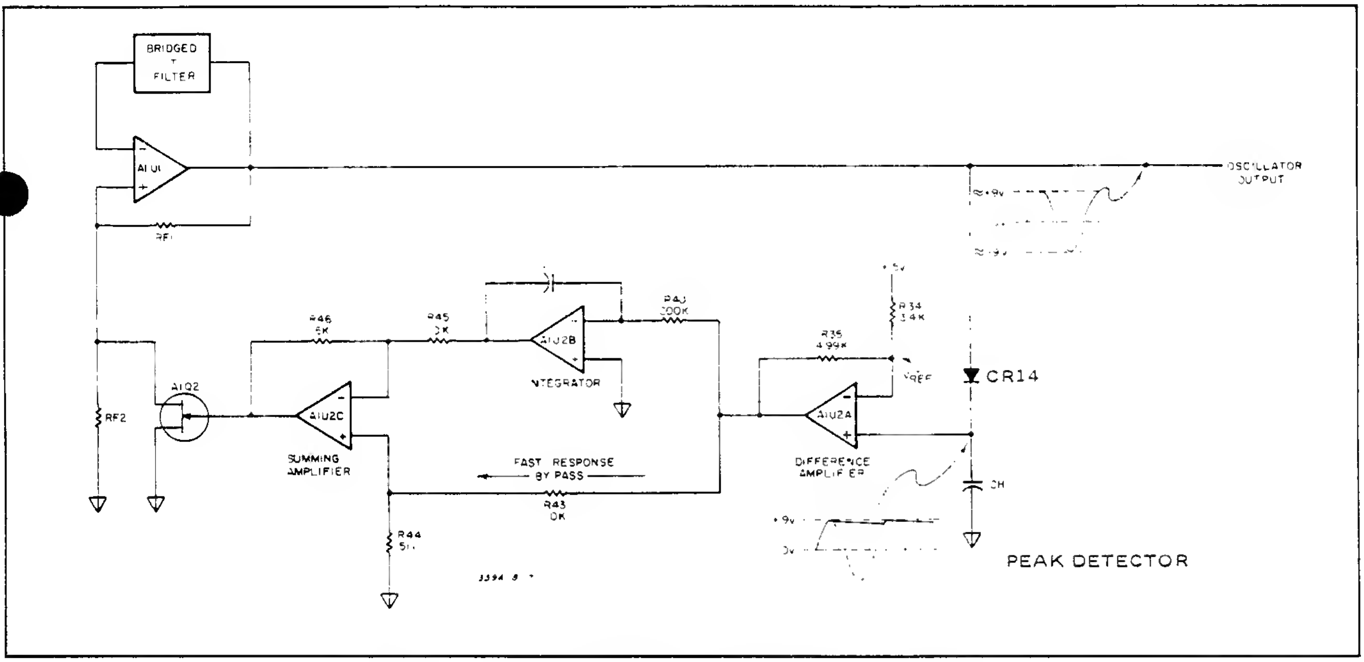


Figure 8-11. Simplified Amplitude Control Circuit.

SCHEMATIC DIAGRAM NOTES

1. Partial component reference designations are shown. For complete reference designations, prefix with assembly designation. Example: R1 mounted on circuit assembly A1 becomes A1R1.

2. Unless otherwise noted, all resistance values are in ohms, all capacitance values are in microfarads.

3. ⏚ Denotes Earth Ground

4. Denotes Chassis Ground

5. Denotes Circuit Ground

6. — — — ———— Denotes Assembly Borderline

7. ———— Denotes Main Signal Path

8. ———— Denotes Feedback Path

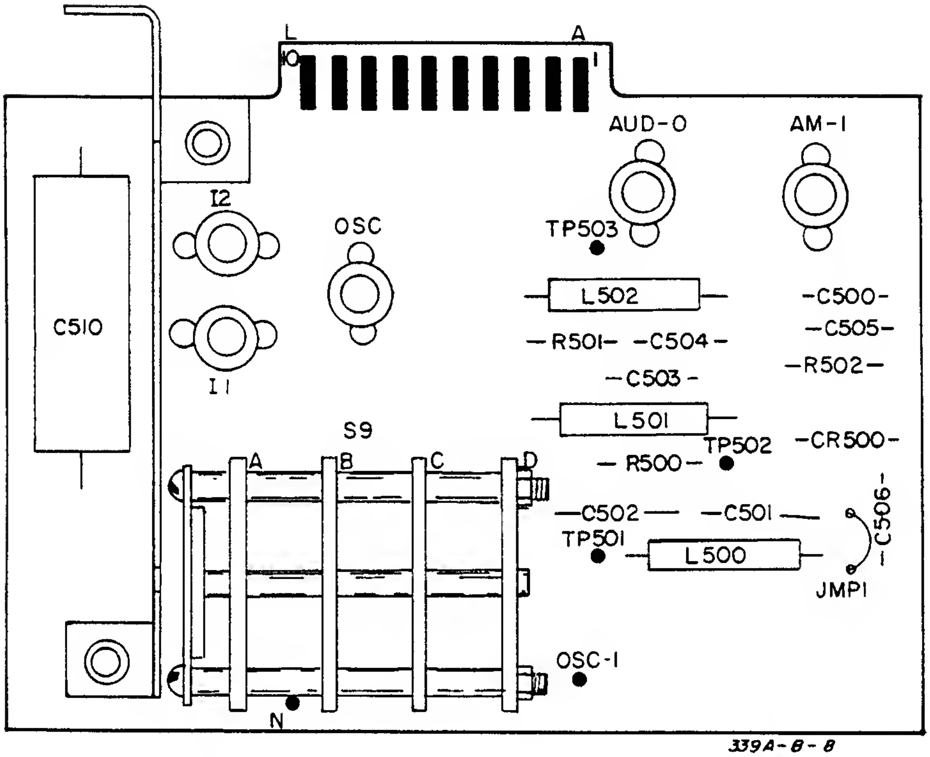
9. — — — — — — — · Denotes Mechanical Connection

10. Denotes Screwdriver Adjustment

11. * Denotes Factory Selected Component
    Average Value shown on schematic

12. 947 Indicates wire colors. Color code same as resistors. For example, 947 indicates white base, yellow wide stripe, and violet narrow stripe

13. TP4 Indicates numbered Test Point



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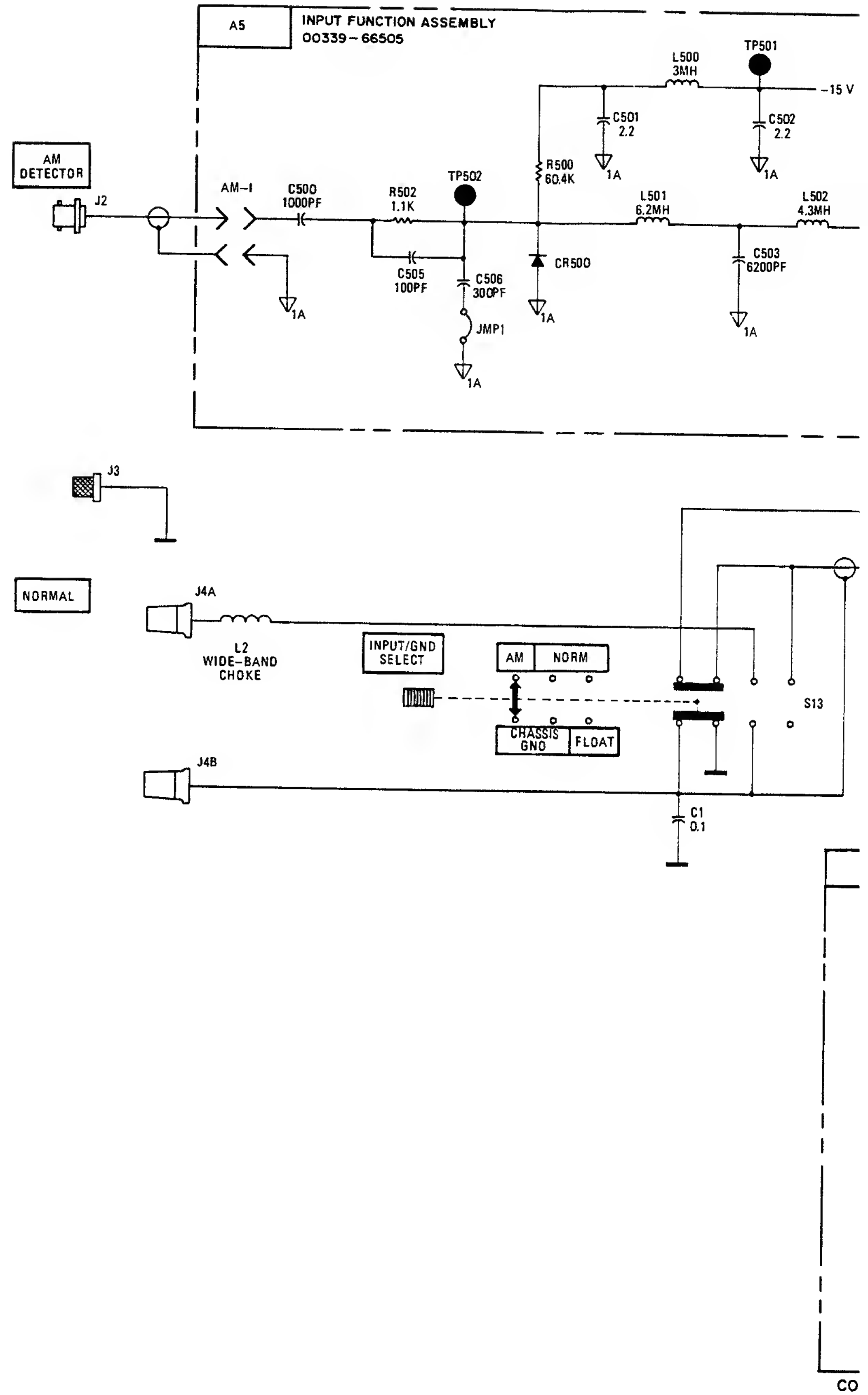


A5
INPUT FUNCTION ASSEMBLY
00339-66505
L500
3MH
TP501
-15 V
C501
2.2
C502
2.2
AM
DETECTOR
J2
AM-I
C500
1000PF
R502
1.1K
TP502
R500
60.4K
1A
L501
6.2MH
L502
4.3MH
C505
100PF
C506
300PF
CR500
C503
6200PF
JMP1
J3
NORMAL
J4A
L2
WIDE-BAND
CHOKE
INPUT/GND
SELECT
AM
NORM
S13
CHASSIS
GND
FLOAT
J4B
C1
0.1
CO

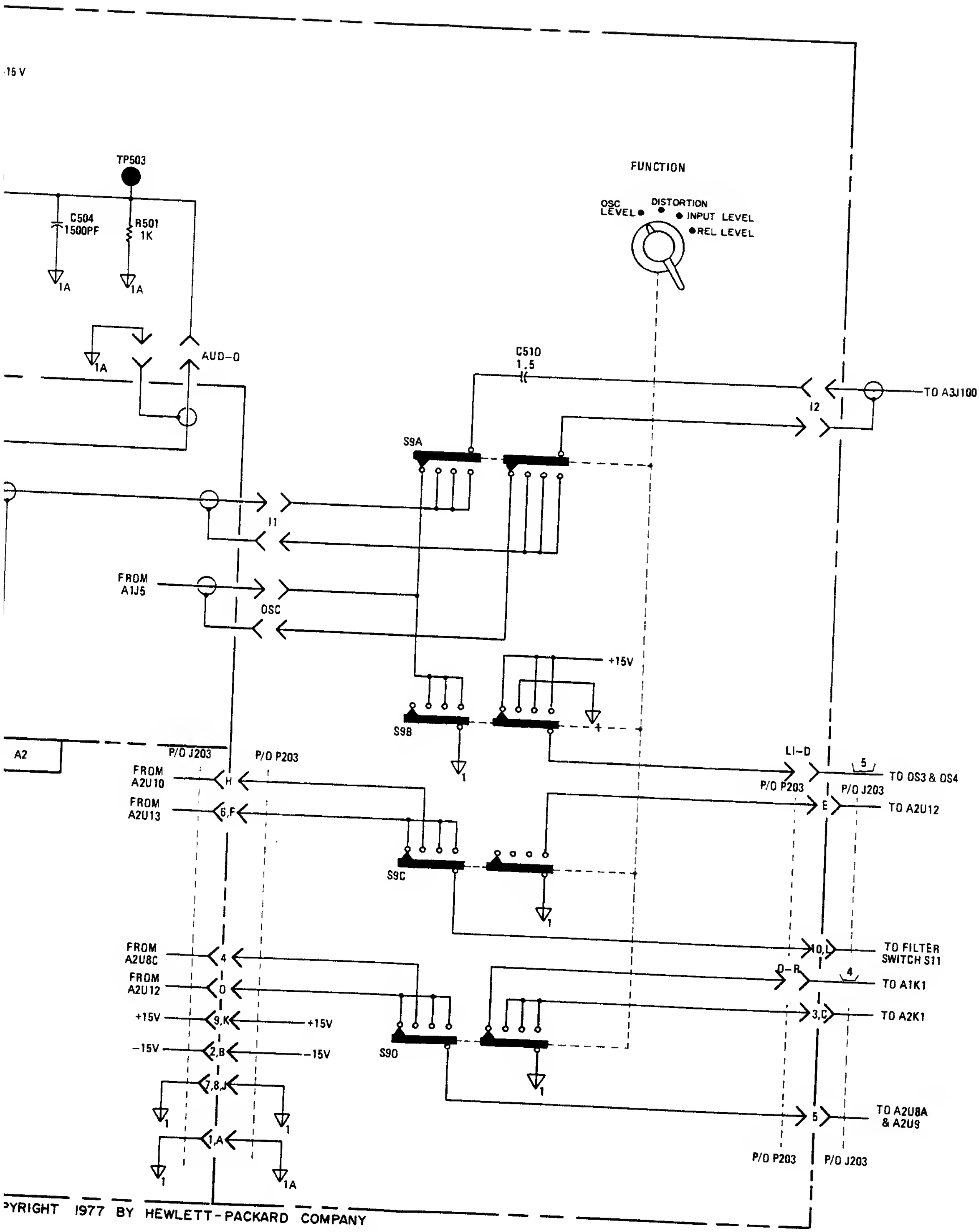
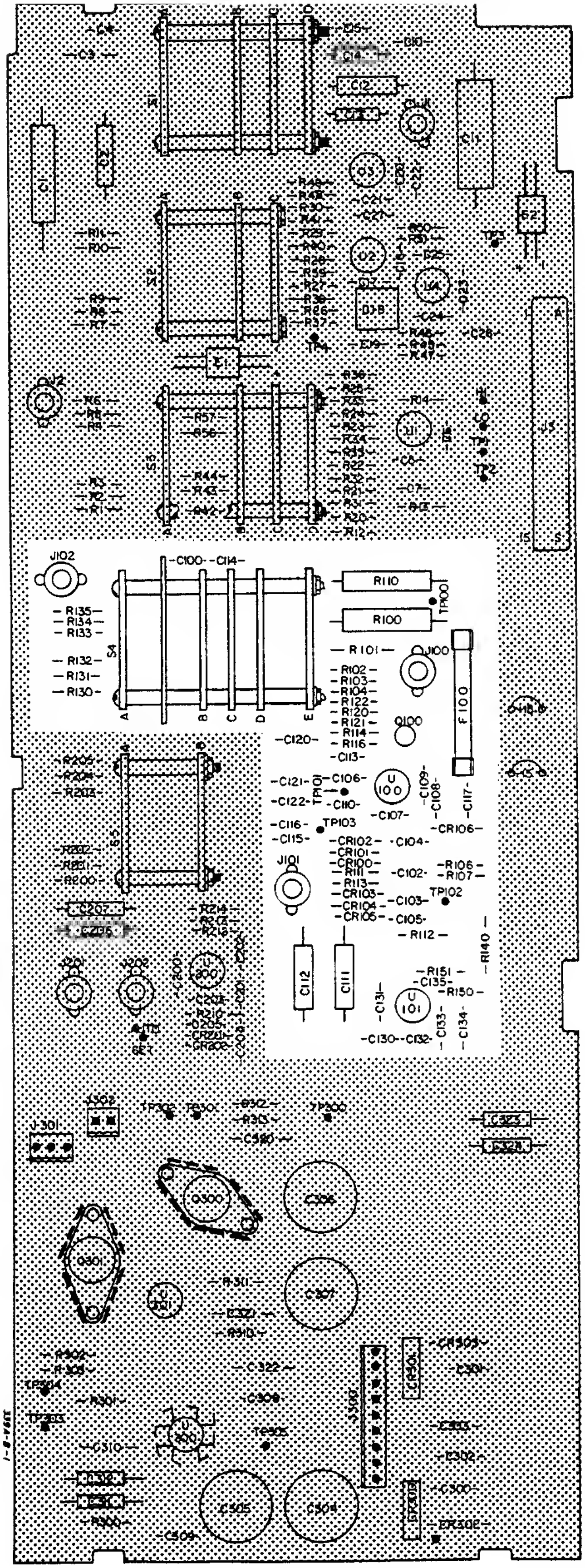


Figure 8-12. AM Detector and Input Switching.



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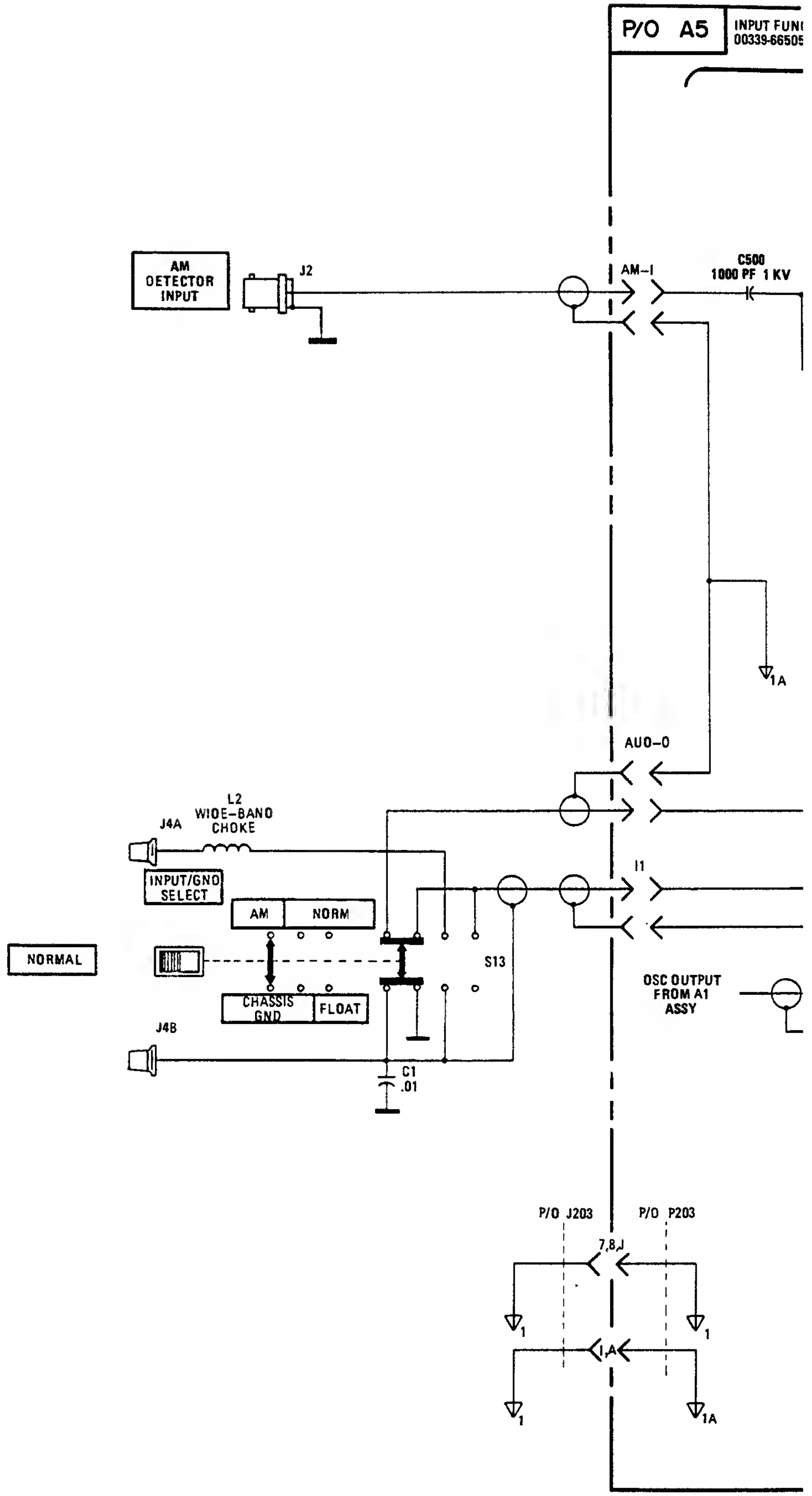
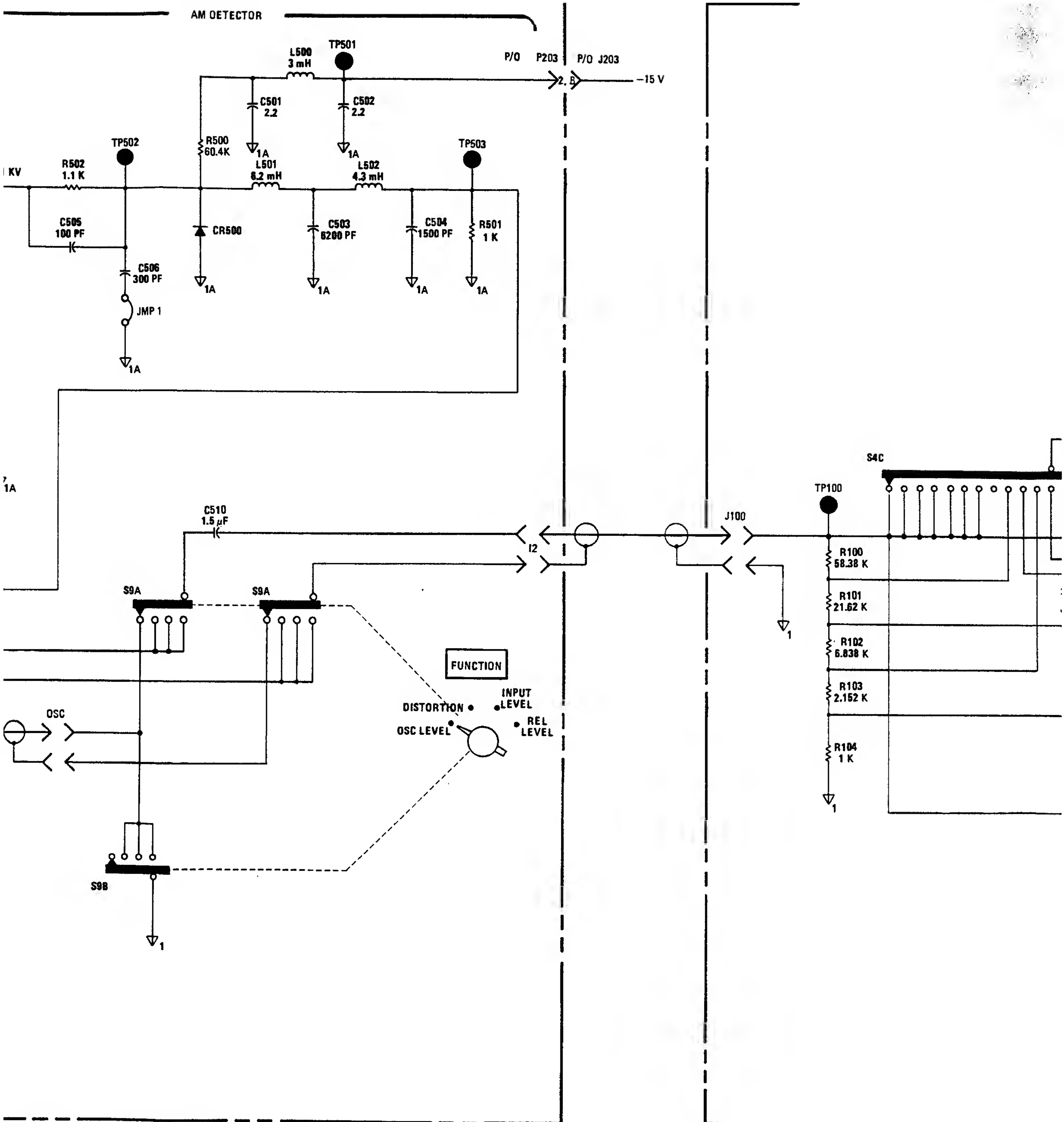
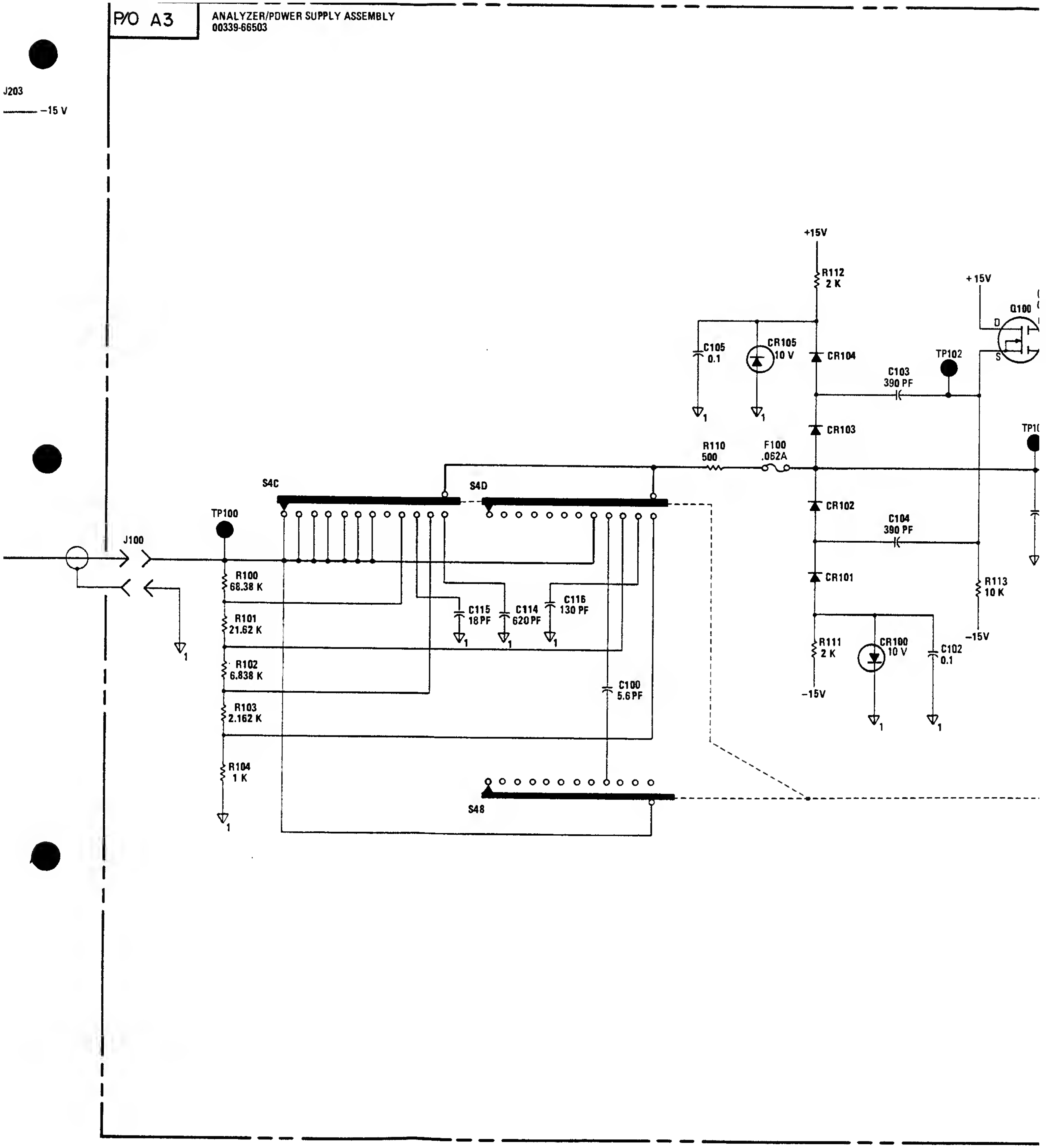
ΔA CAPACITOR A3C132 HAS BEEN CHAN
COMPONENT TO COMPENSATE FOR GA
FERENCES. IN AMPLIFIER A3U101 CAP
FROM 4.7 pF TO 15 pF.

ΔA CAPACITOR A3C132 HAS BEEN CHANGED TO A SELECTED COMPONENT TO COMPENSATE FOR GAIN BANDWIDTH DIFFERENCES. IN AMPLIFIER A3U101 CAPACITANCE RANGE IS FROM 4.7 pF TO 15 pF.





BY HEWLETT PACKARD COMPANY



P/O A3
ANALYZER/POWER SUPPLY ASSEMBLY
00339-66503
J203
−15 V
+15V
R112
2 K
+15V
Q100
D
S
C105
0.1
CR105
10 V
CR104
TP102
C103
390 PF
CR103
R110
500
F100
.062A
S4C
S4D
TP100
CR102
C104
390 PF
J100
R100
68.38 K
CR101
R113
10 K
C115
18 PF
C114
620 PF
C116
130 PF
R101
21.62 K
−15V
R111
2 K
CR100
10 V
C102
0.1
R102
6.838 K
−15V
C100
5.6 PF
R103
2.162 K
R104
1 K
S4B

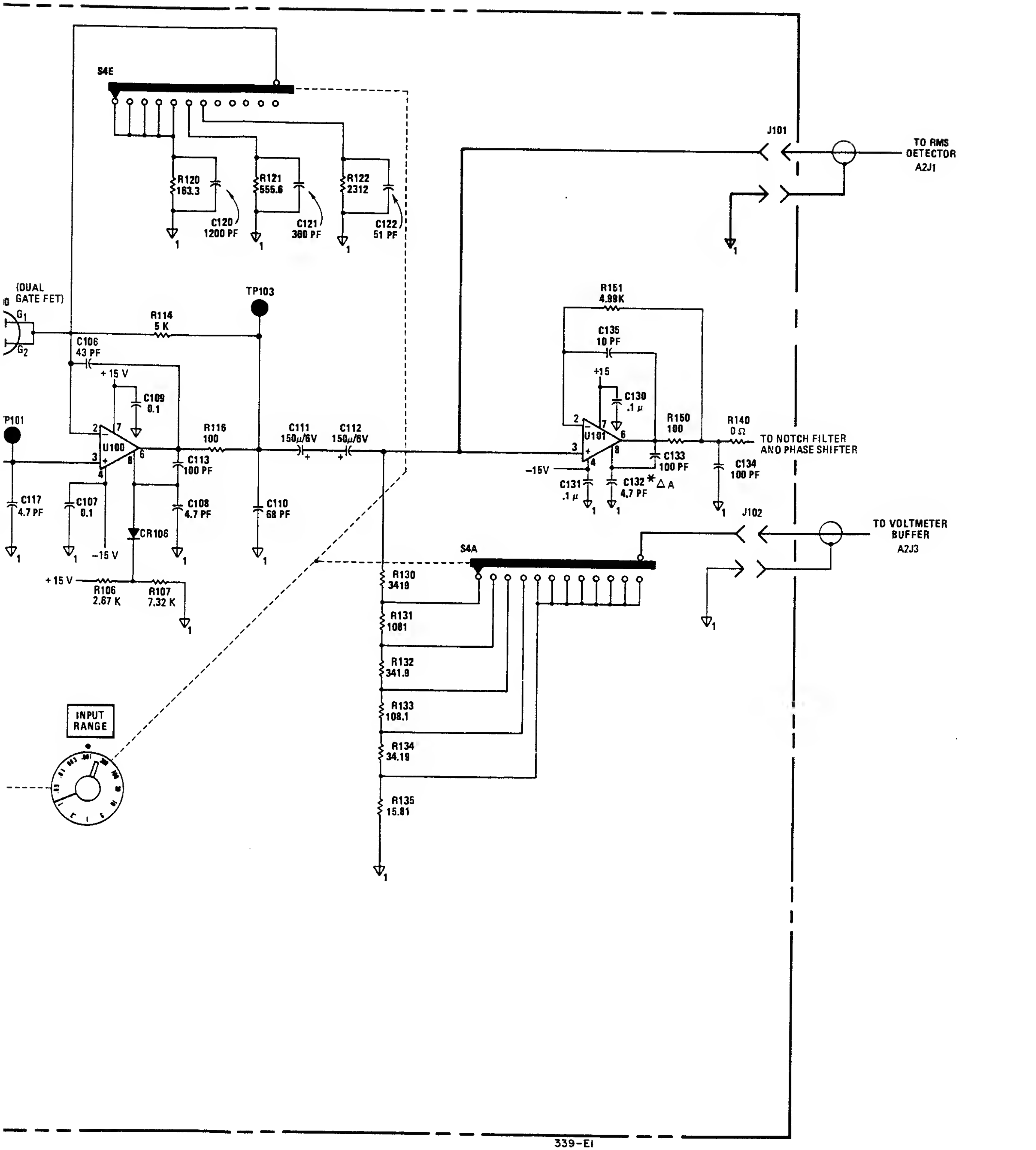
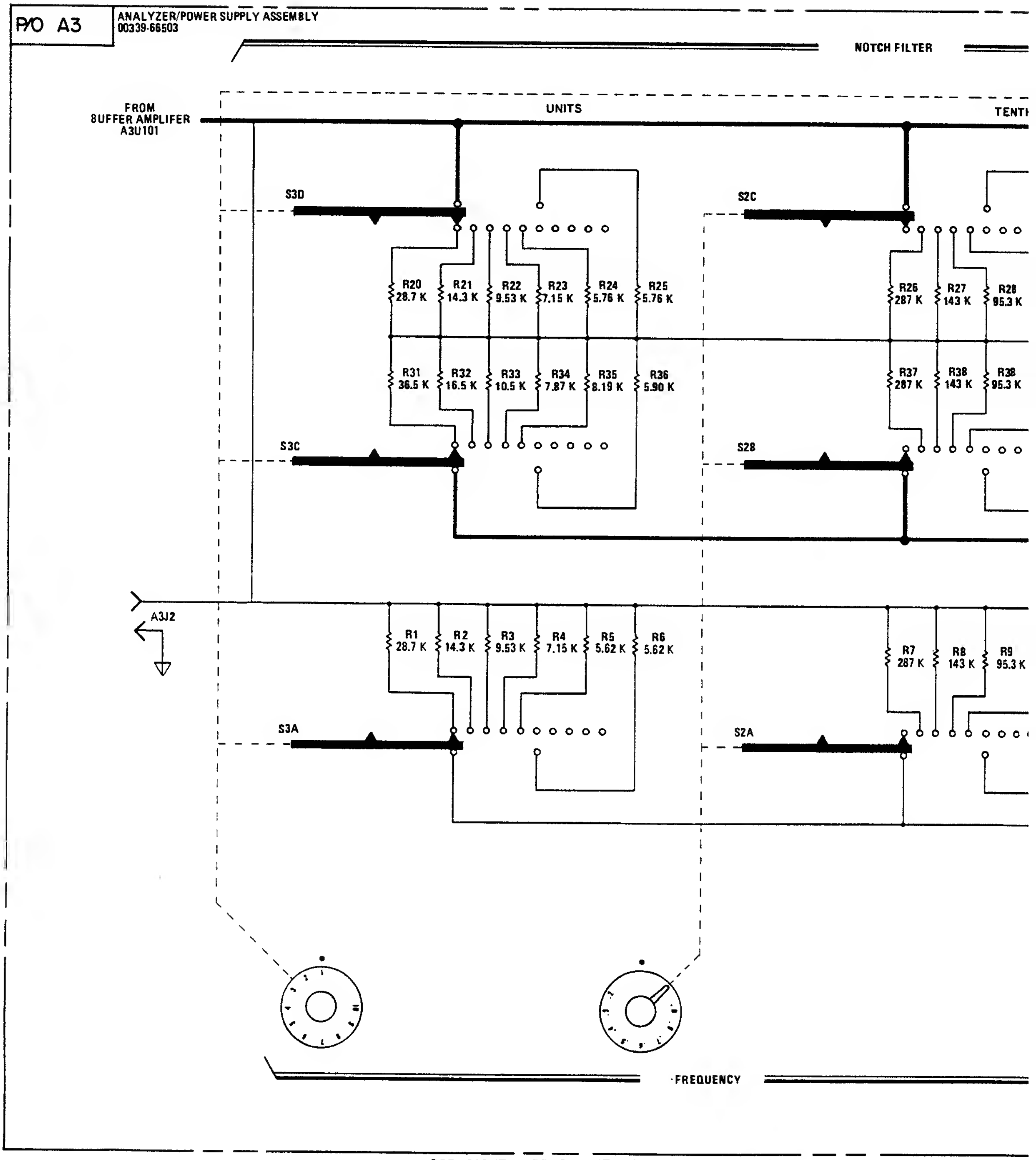
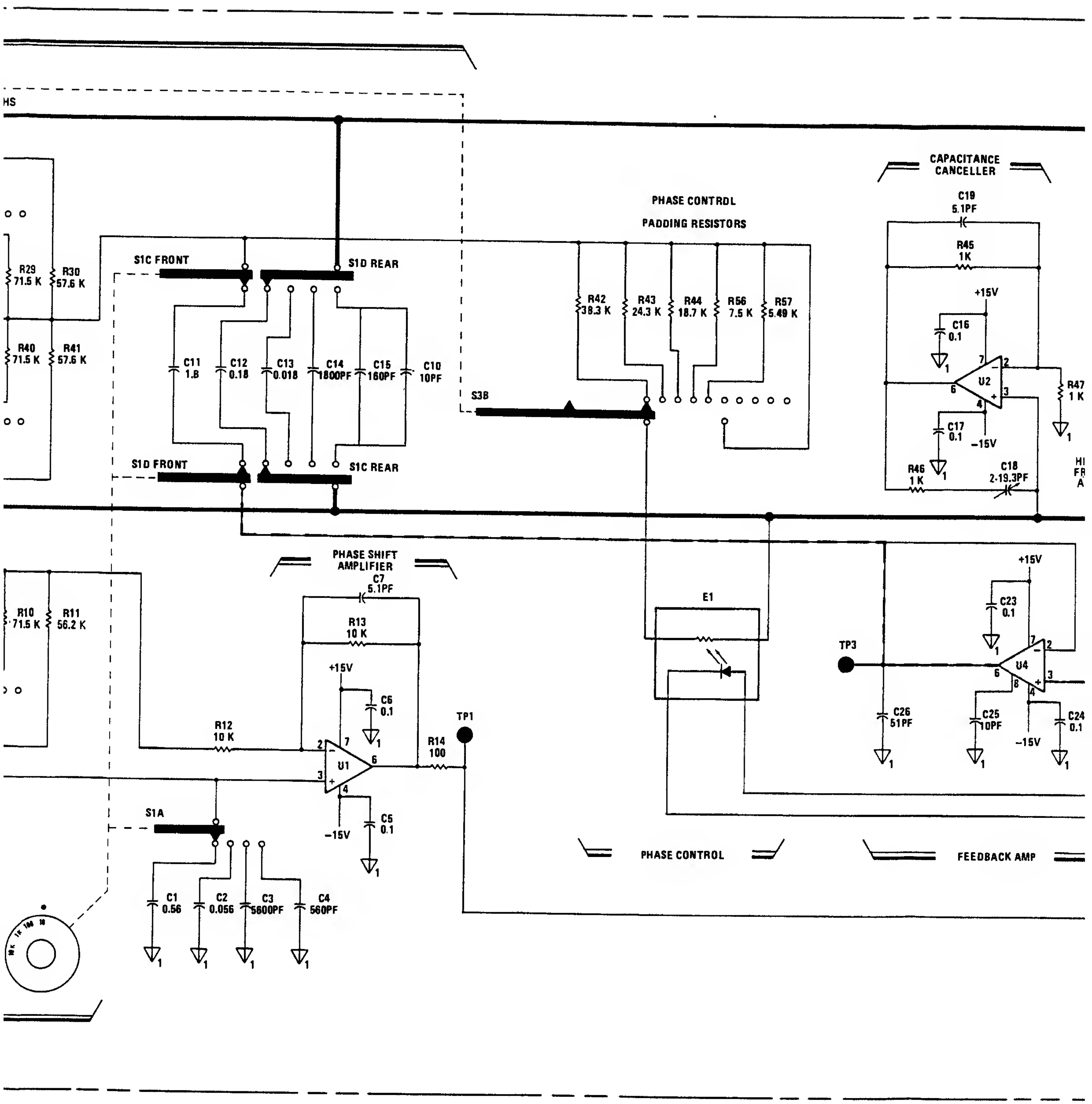
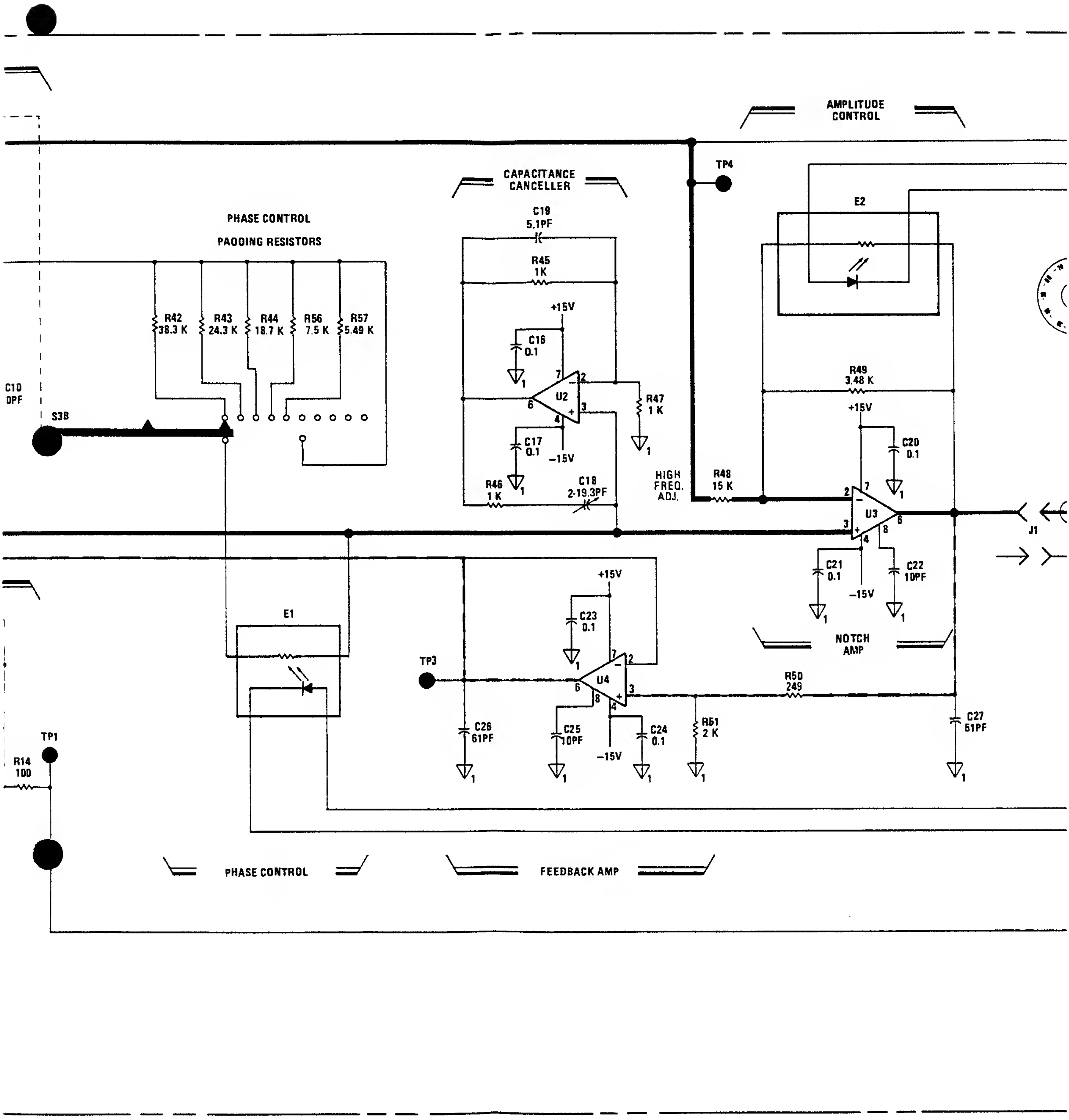


Figure 8-13. Input Attenuator and Input Amplifier.


P/O A3
ANALYZER/POWER SUPPLY ASSEMBLY
00339-66503
NOTCH FILTER
FROM
BUFFER AMPLIFER
A3U101
UNITS
TENTH
S3D
S2C
R20 28.7 K
R21 14.3 K
R22 9.53 K
R23 7.15 K
R24 5.76 K
R25 5.76 K
R26 287 K
R27 143 K
R28 95.3 K
R31 36.5 K
R32 16.5 K
R33 10.5 K
R34 7.87 K
R35 8.19 K
R36 5.90 K
R37 287 K
R38 143 K
R39 95.3 K
S3C
S2B
A3J2
R1 28.7 K
R2 14.3 K
R3 9.53 K
R4 7.15 K
R5 5.62 K
R6 5.62 K
R7 287 K
R8 143 K
R9 95.3 K
S3A
S2A
FREQUENCY



CAPACITANCE CANCELLER
PHASE CONTROL
PADDING RESISTORS
S1C FRONT
S1D REAR
S1D FRONT
S1C REAR
S3B
S1A
PHASE SHIFT AMPLIFIER
PHASE CONTROL
FEEDBACK AMP
R29 71.5 K
R30 57.6 K
R40 71.5 K
R41 57.6 K
R10 71.5 K
R11 56.2 K
C11 1.8
C12 0.18
C13 0.018
C14 1800PF
C15 180PF
C10 10PF
R42 38.3 K
R43 24.3 K
R44 18.7 K
R56 7.5 K
R57 5.49 K
C19 5.1PF
R45 1K
C16 0.1
C17 0.1
R47 1 K
R46 1 K
C18 2-19.3PF
U2
+15V
-15V
C7 5.1PF
R13 10 K
C6 0.1
C5 0.1
R12 10 K
R14 100
TP1
U1
E1
TP3
C23 0.1
C26 51PF
C25 10PF
C24 0.1
U4
C1 0.56
C2 0.056
C3 5600PF
C4 560PF


AMPLITUDE CONTROL
CAPACITANCE CANCELLER
TP4
C19
5.1PF
E2
PHASE CONTROL
PADDING RESISTORS
R45
1K
R42
38.3 K
R43
24.3 K
R44
18.7 K
R56
7.5 K
R57
5.49 K
+15V
C16
0.1
U2
R47
1 K
C10
0PF
S3B
C17
0.1
-15V
R49
3.48 K
+15V
C20
0.1
R46
1 K
C18
2-19.3PF
HIGH
FREQ.
ADJ.
R48
15 K
U3
J1
C21
0.1
-15V
C22
10PF
E1
+15V
C23
0.1
NOTCH
AMP
TP3
U4
R50
249
C26
61PF
C25
10PF
-15V
C24
0.1
R51
2 K
C27
51PF
TP1
R14
100
PHASE CONTROL
FEEDBACK AMP

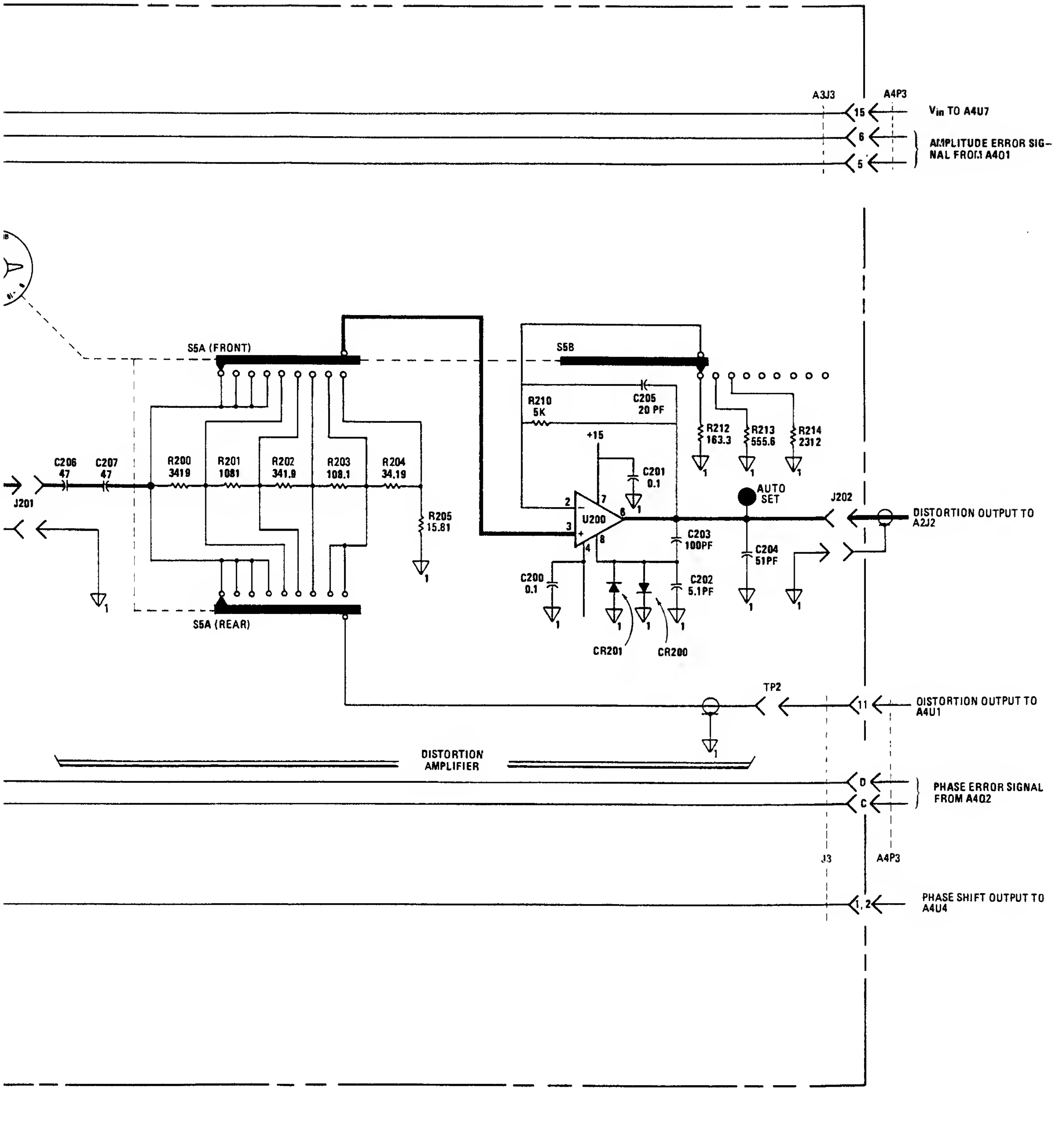
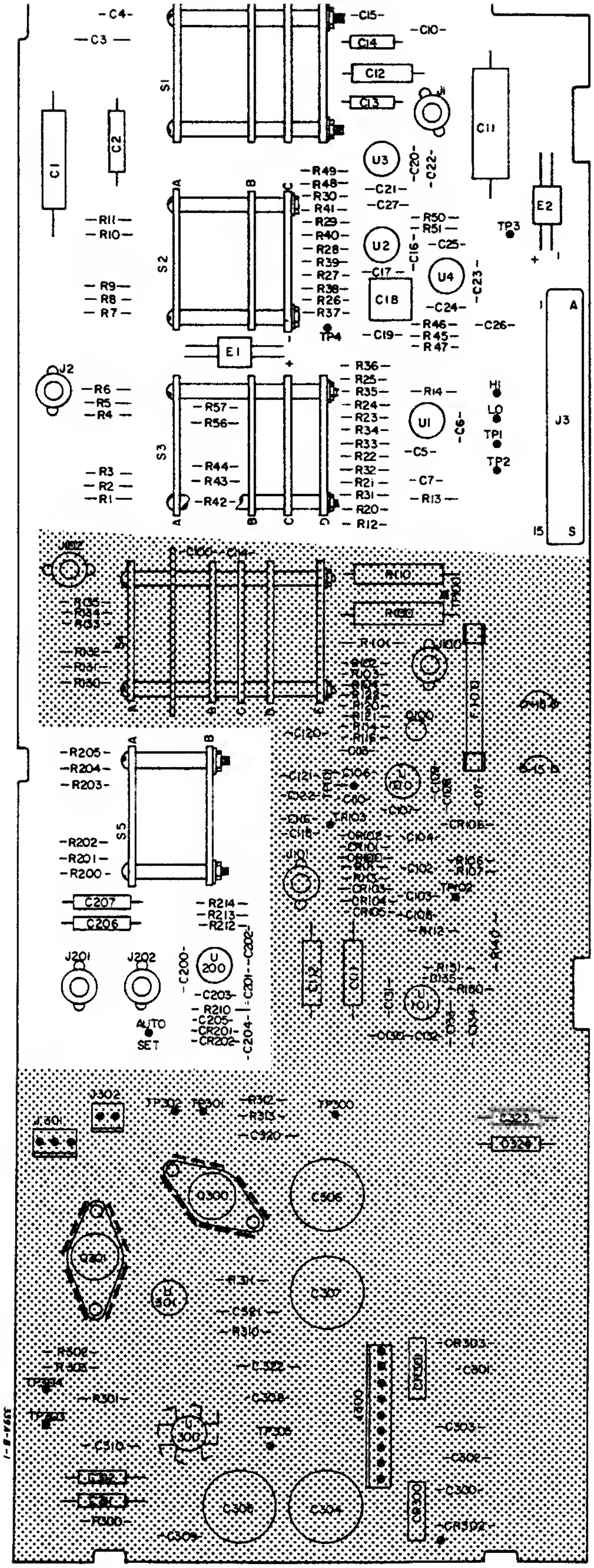


Figure 8-14. Fundamental Rejection Circuit.



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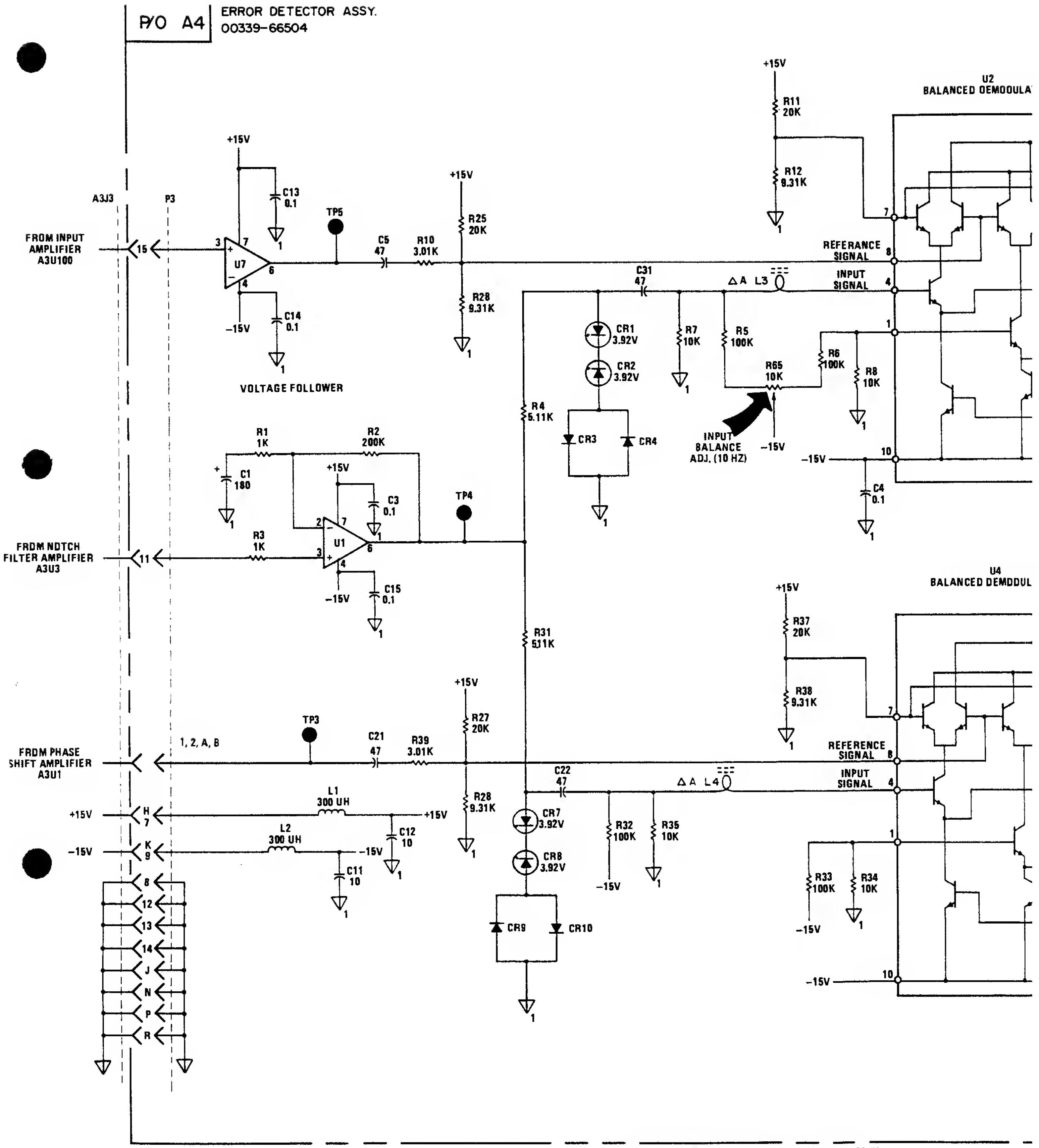
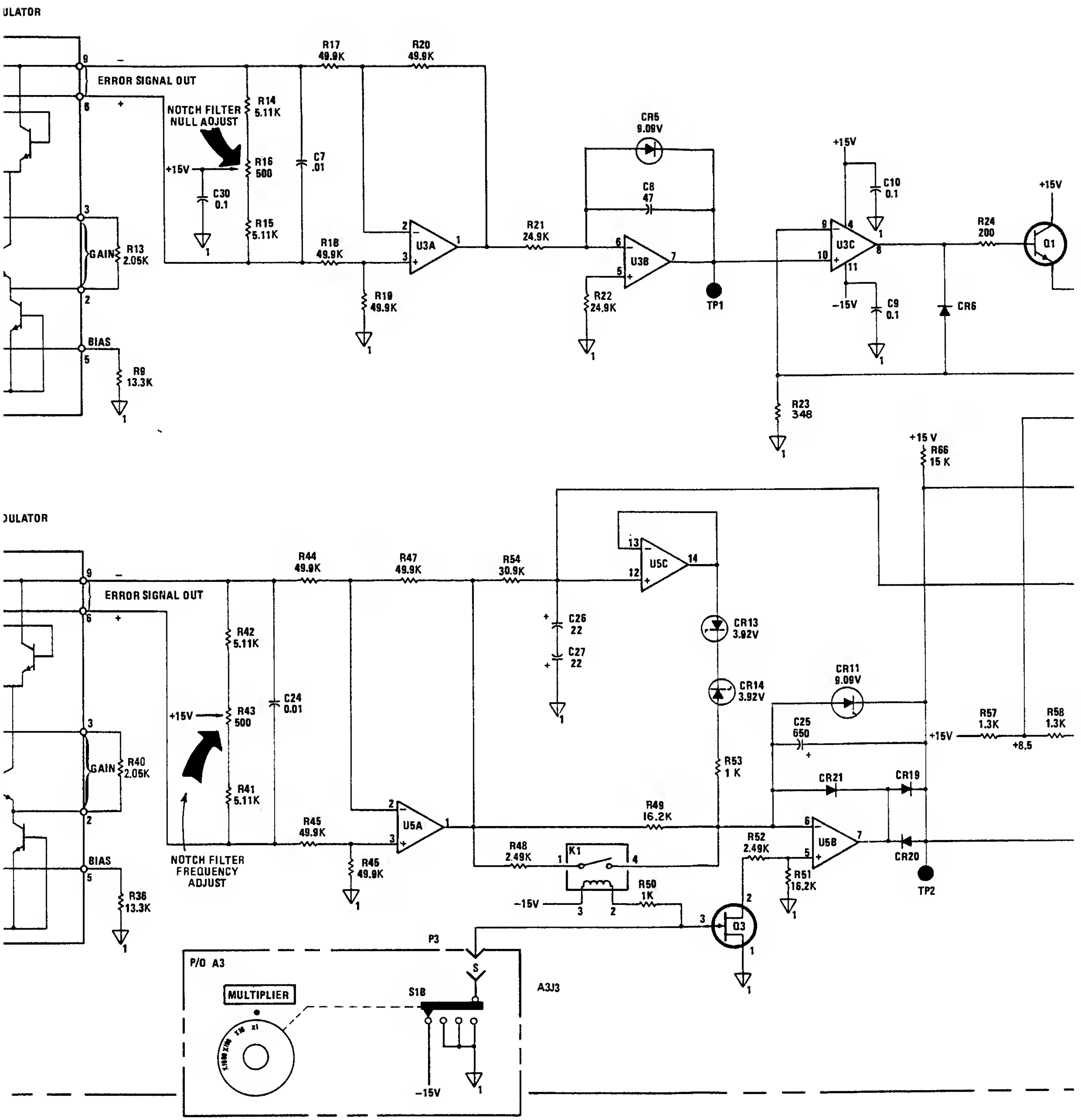
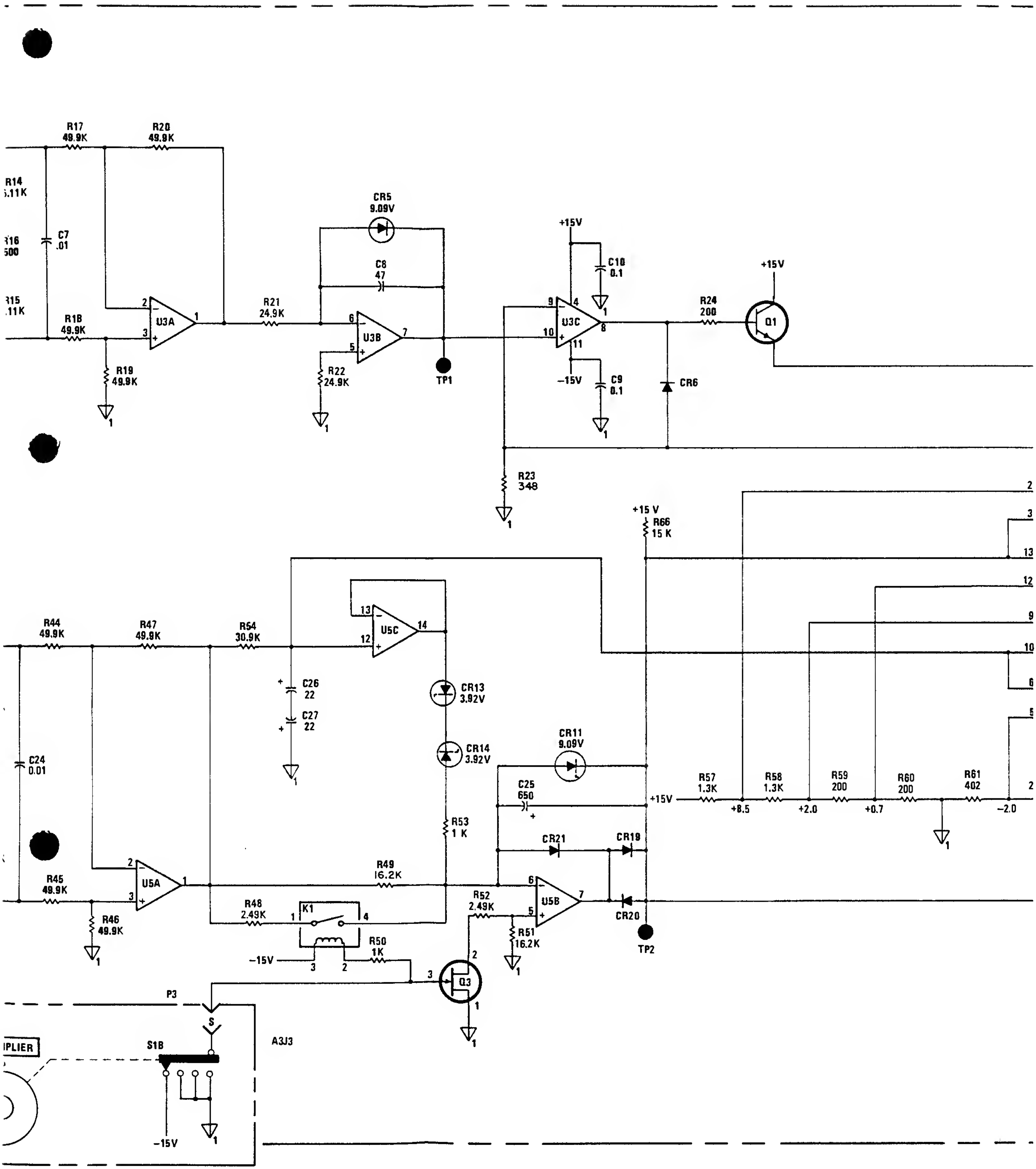


P/O A4
ERROR DETECTOR ASSY.
00339-66504
U2
BALANCED DEMODULAT
U4
BALANCED DEMODUL
FROM INPUT AMPLIFIER A3U100
FROM NOTCH FILTER AMPLIFIER A3U3
FROM PHASE SHIFT AMPLIFIER A3U1
A3J3
P3
VOLTAGE FOLLOWER
REFERANCE SIGNAL
INPUT SIGNAL
REFERENCE SIGNAL
INPUT BALANCE ADJ. (10 HZ)
TP5
TP4
TP3



ULATOR
ERROR SIGNAL OUT
NOTCH FILTER NULL ADJUST
GAIN
BIAS
R13 2.05K
R9 13.3K
R14 5.11K
R16 500
R15 5.11K
+15V
C30 0.1
C7 .01
R17 49.9K
R20 49.9K
R18 49.9K
R19 49.9K
U3A
R21 24.9K
CR5 9.09V
C8 47
U3B
R22 24.9K
TP1
+15V
C10 0.1
U3C
-15V
C9 0.1
R24 200
Q1
CR6
R23 348
+15 V
R66 15 K
ULATOR
ERROR SIGNAL OUT
GAIN
R40 2.05K
BIAS
R36 13.3K
R42 5.11K
+15V
R43 500
R41 5.11K
C24 0.01
NOTCH FILTER FREQUENCY ADJUST
R44 49.9K
R47 49.9K
R54 30.9K
U5C
C26 22
C27 22
CR13 3.92V
CR14 3.92V
CR11 9.09V
C25 650
+15V
R57 1.3K
R58 1.3K
+8.5
R53 1 K
CR21
CR19
R45 49.9K
R46 49.9K
U5A
R49 16.2K
R48 2.49K
K1
R52 2.49K
U5B
CR20
TP2
R51 16.2K
-15V
R50 1K
Q3
P3
P/O A3
MULTIPLIER
S1B
A3J3
-15V


R17
49.9K
R20
49.9K
R14
5.11K
R16
500
C7
.01
R15
.11K
R18
49.9K
U3A
R19
49.9K
CR5
9.09V
C8
47
R21
24.9K
U3B
R22
24.9K
TP1
+15V
C10
0.1
U3C
-15V
C9
0.1
+15V
R24
200
Q1
CR6
R23
348
+15 V
R66
15 K
R44
49.9K
R47
49.9K
R54
30.9K
U5C
C26
22
C27
22
C24
0.01
CR13
3.92V
CR14
3.92V
CR11
9.09V
C25
650
R53
1 K
CR21
CR19
U5A
R45
49.9K
R46
49.9K
R49
16.2K
R48
2.49K
K1
R52
2.49K
U5B
R51
16.2K
CR20
TP2
R50
1K
-15V
Q3
P3
A3J3
S1B
-15V
PLIER
+15V
R57
1.3K
R58
1.3K
R59
200
R60
200
R61
402
+8.5
+2.0
+0.7
-2.0

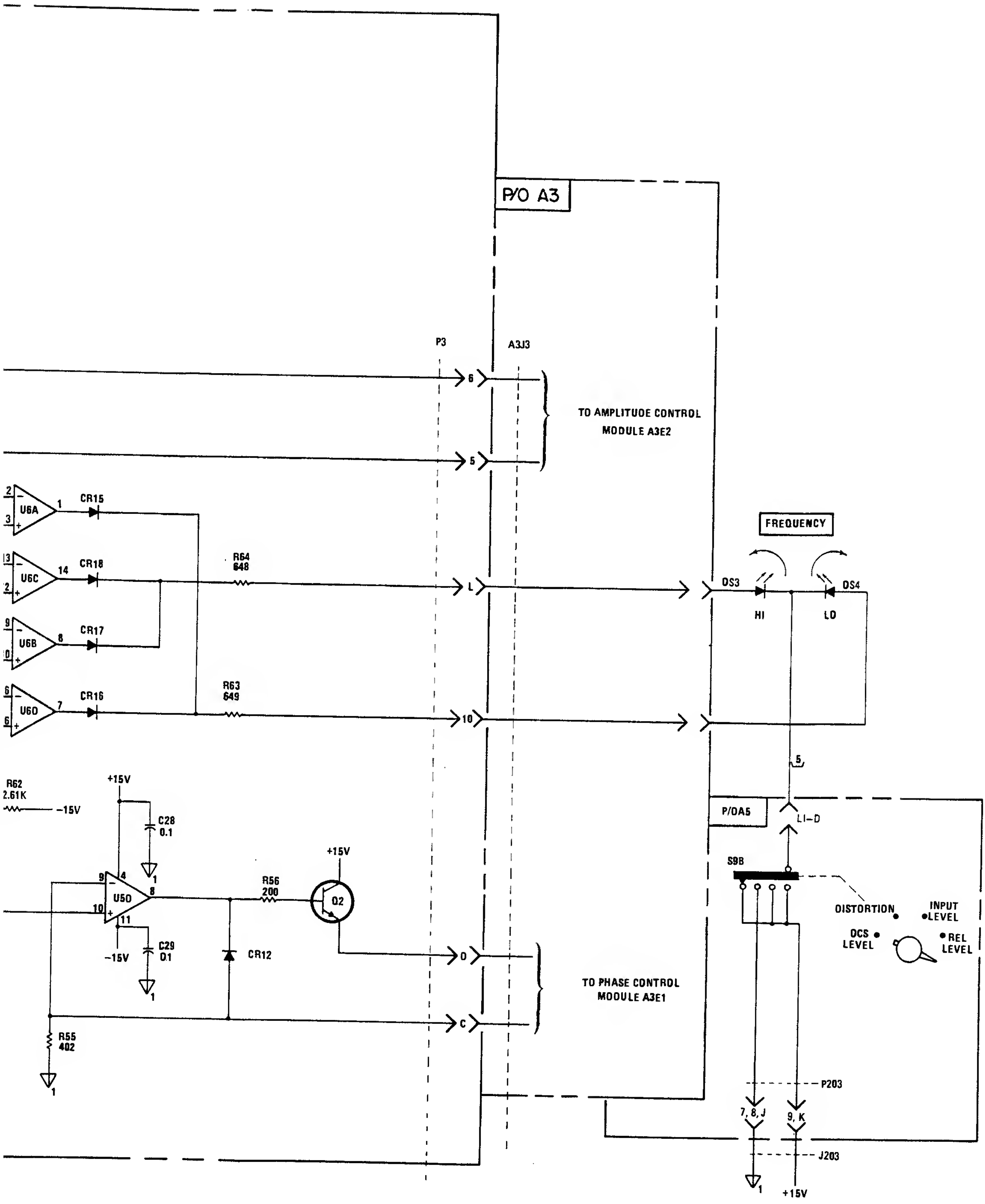
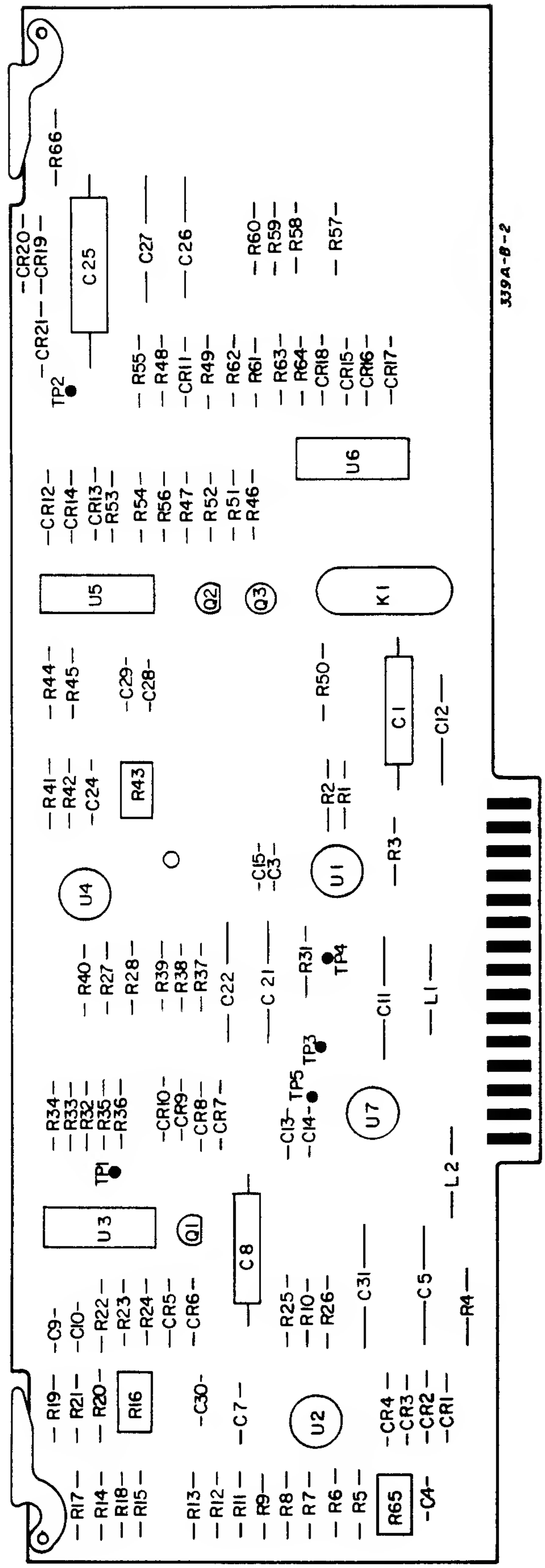
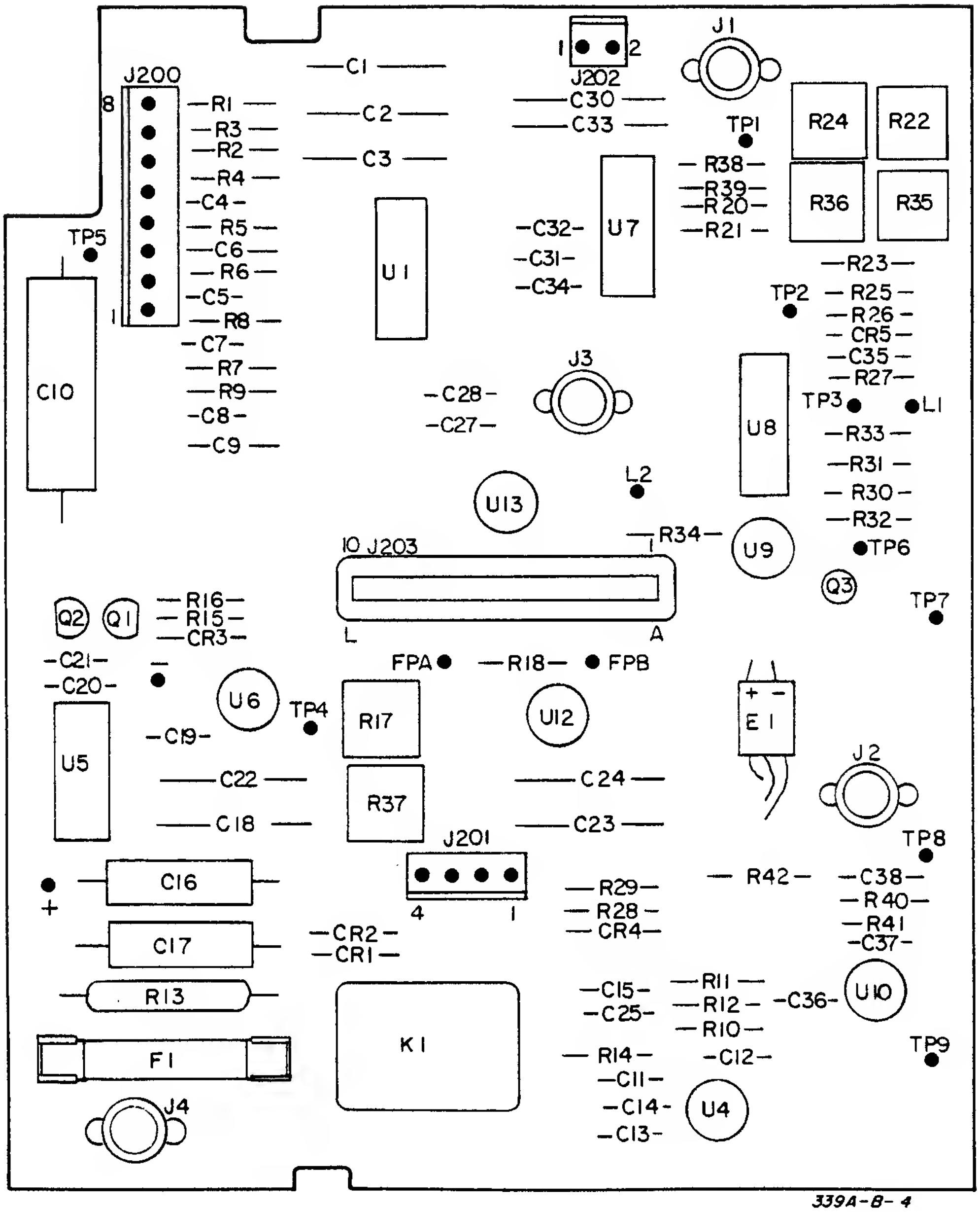


Figure 8-15. Error Detector Circuits.

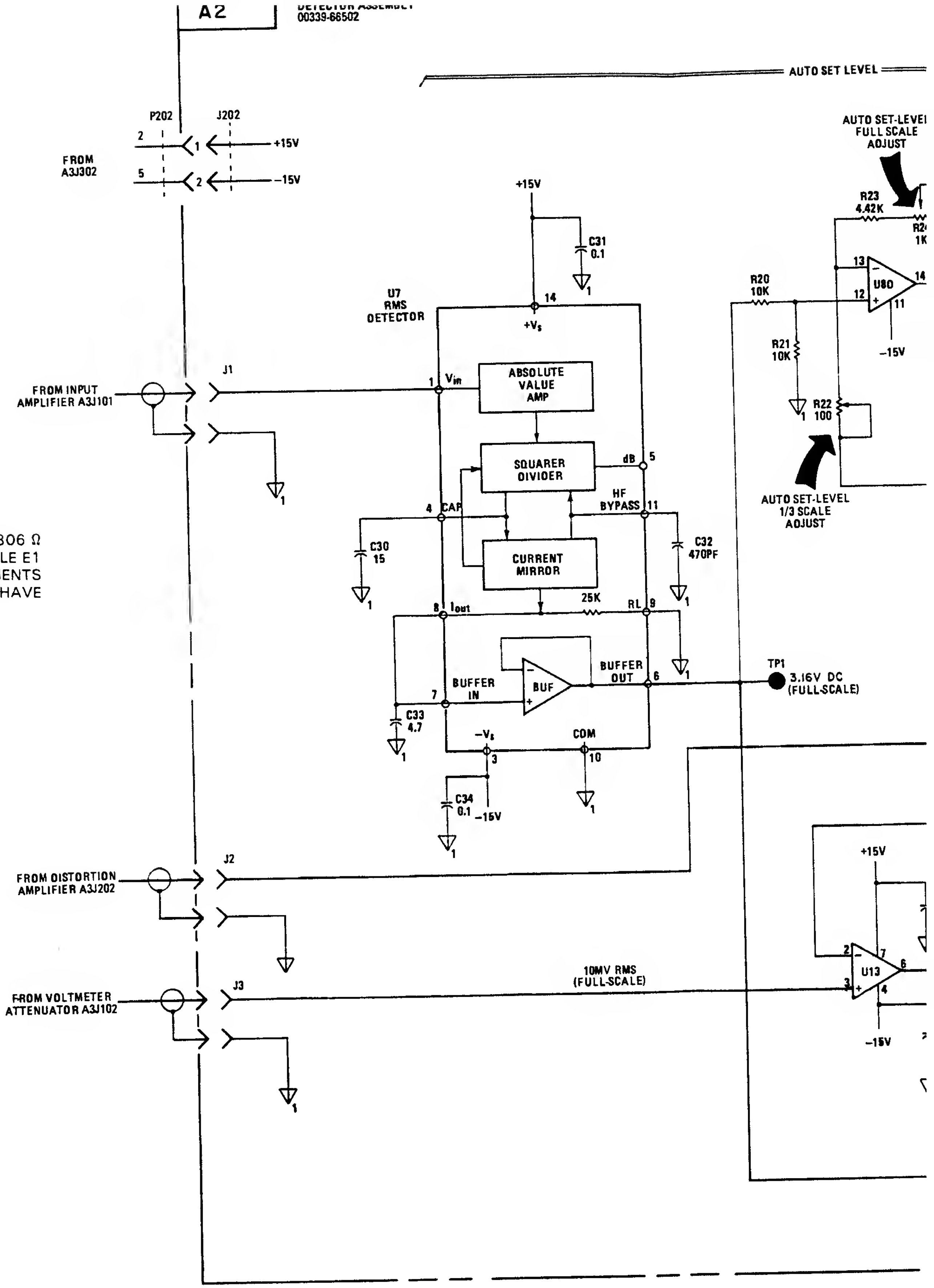


A4
00339-66504
Rev. C

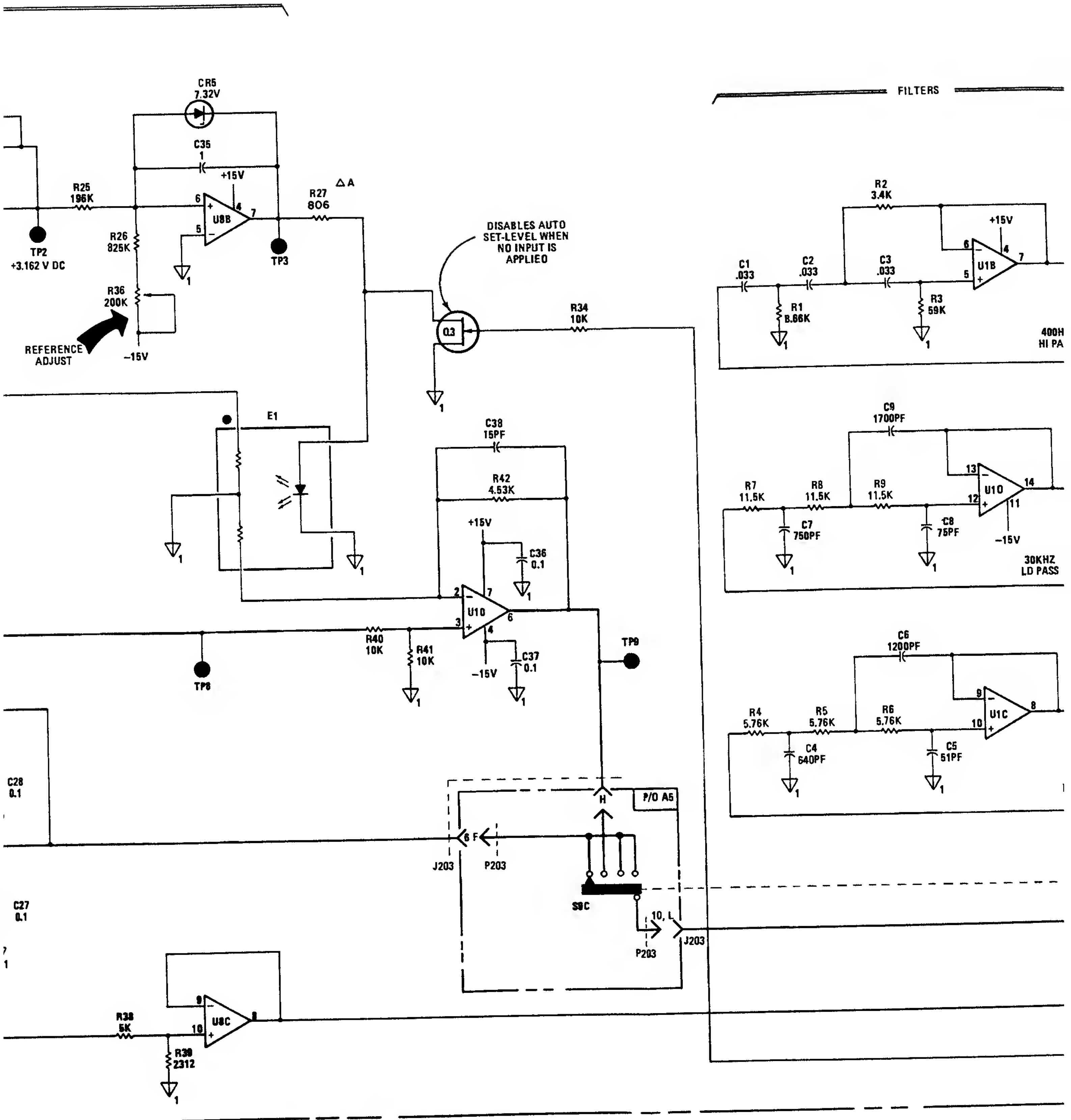
ΔA FERRITE BEADS (L3 & L4) HAVE BEEN ADDED TO PIN 4 OF U2 AND U4 TO PREVENT HIGH FREQUENCY OSCILLATIONS (APPROXIMATELY 300 MHz).

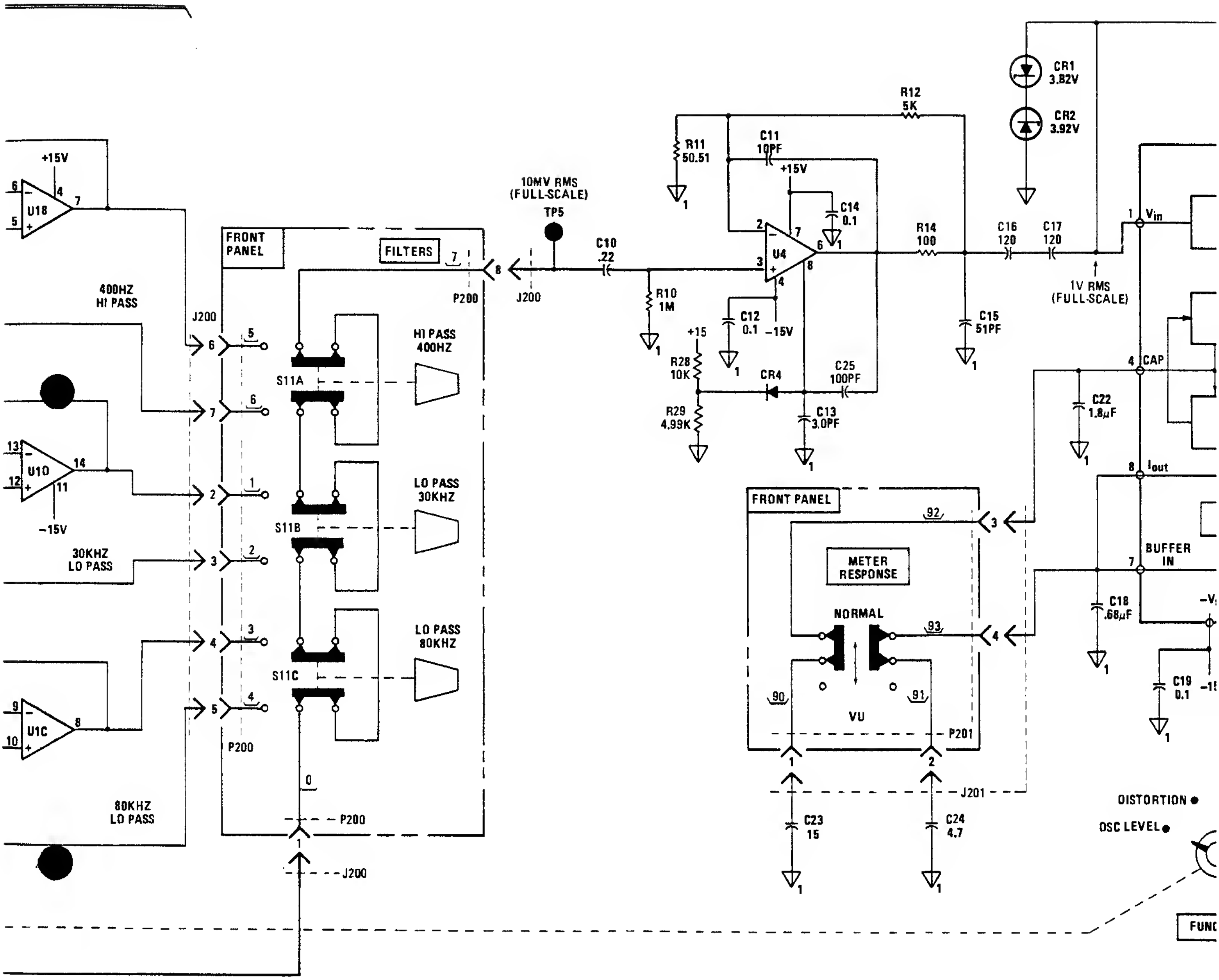


A2
00339-66502
Rev. A



CHANGED FROM 1 kΩ to 806 Ω
DRIVE FOR PHOTO MODULE E1
: CONDITIONS. INSTRUMENTS
)A00196 AND GREATER HAVE
).


FILTERS
CR5
7.32V
C35
1
+15V
R25
196K
U8B
TP2
+3.162 V DC
TP3
R26
825K
R36
200K
REFERENCE
ADJUST
-15V
R27
806
△A
DISABLES AUTO
SET-LEVEL WHEN
NO INPUT IS
APPLIED
Q3
R34
10K
E1
C38
15PF
R42
4.53K
+15V
C36
0.1
U1D
R40
10K
R41
10K
-15V
C37
0.1
TP8
TP9
C28
0.1
C27
0.1
P/O A5
J203
P203
S8C
10, L
R38
5K
U8C
R39
2312
R2
3.4K
+15V
U1B
C1
.033
C2
.033
C3
.033
R1
8.66K
R3
59K
400H
HI PA
C9
1700PF
R7
11.5K
R8
11.5K
R9
11.5K
C7
750PF
C8
75PF
-15V
30KHZ
LO PASS
C6
1200PF
R4
5.76K
R5
5.76K
R6
5.76K
U1C
C4
640PF
C5
51PF



+15V
U18
-15V
U1D
U1C
400HZ
HI PASS
30KHZ
LO PASS
80KHZ
LO PASS
J200
P200
FRONT PANEL
FILTERS
HI PASS 400HZ
LO PASS 30KHZ
LO PASS 80KHZ
S11A
S11B
S11C
10MV RMS (FULL-SCALE)
TP5
C10 .22
R10 1M
R11 50.51
C11 10PF
R12 5K
U4
C14 0.1
C12 0.1
R28 10K
R29 4.99K
CR4
C25 100PF
C13 3.0PF
R14 100
C15 51PF
C16 120
C17 120
1V RMS (FULL-SCALE)
CR1 3.82V
CR2 3.92V
Vin
CAP
C22 1.8µF
Iout
BUFFER IN
C18 .68µF
C19 0.1
FRONT PANEL
METER RESPONSE
NORMAL
VU
P201
J201
C23 15
C24 4.7
DISTORTION
OSC LEVEL

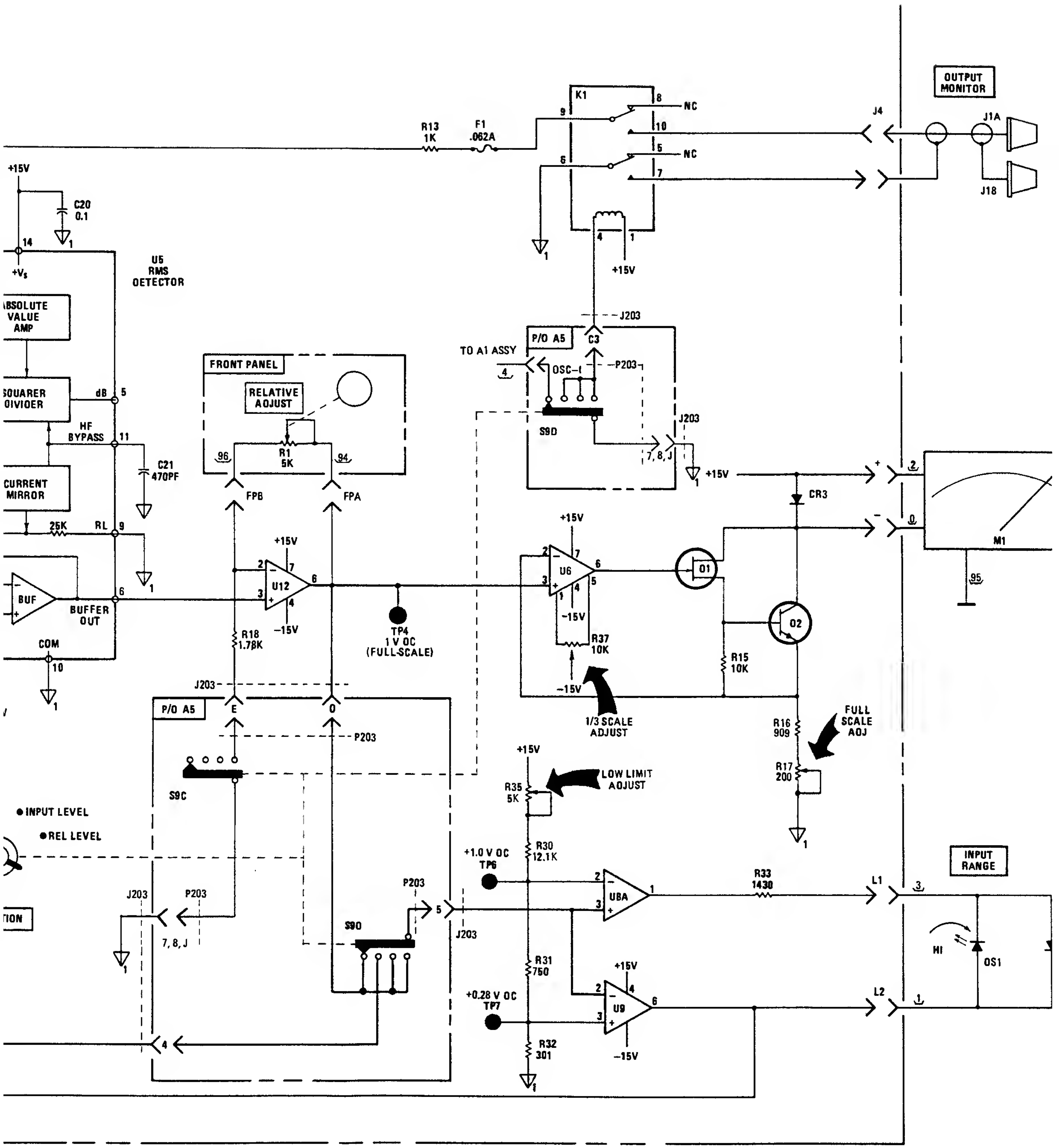
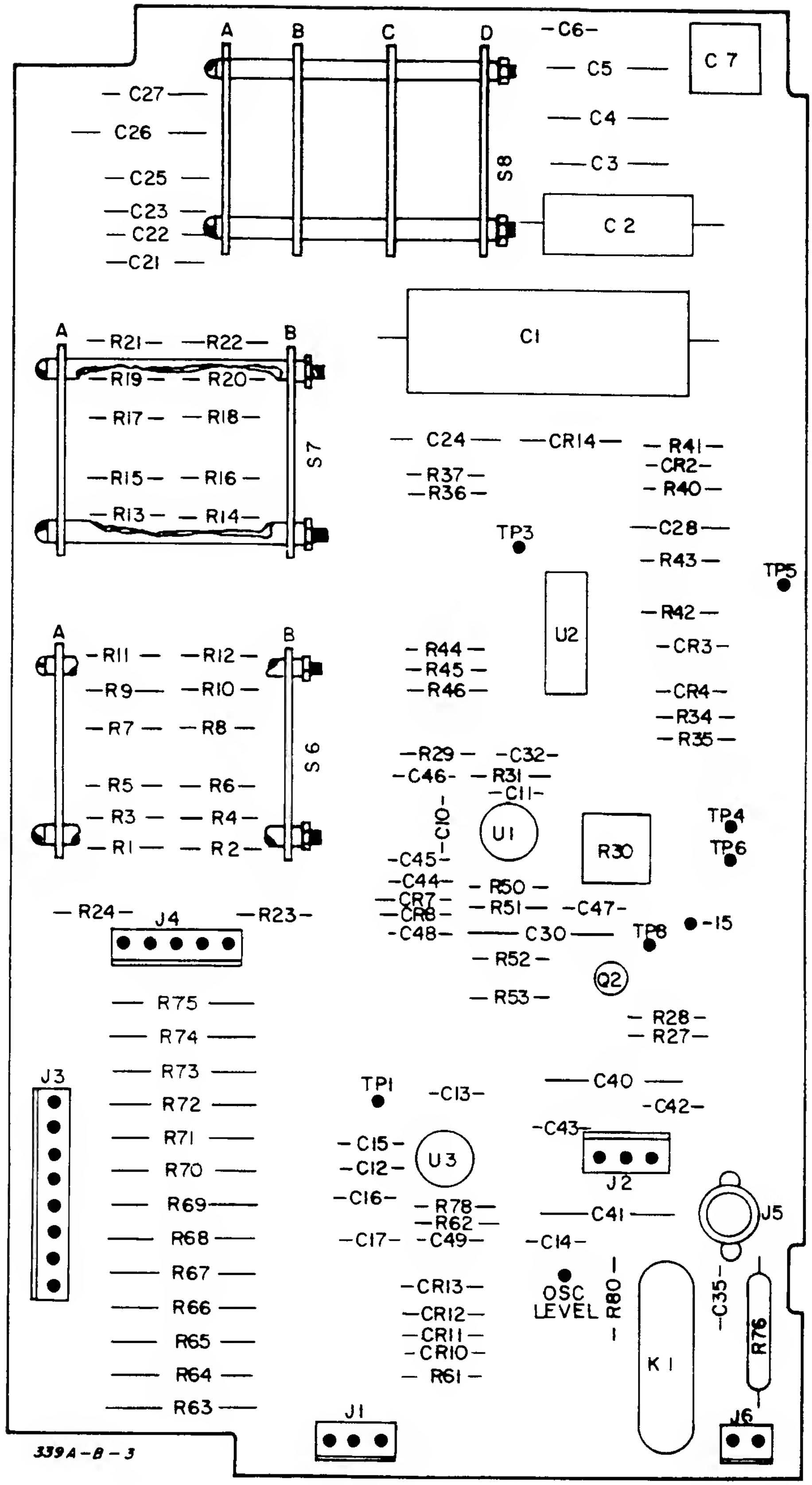
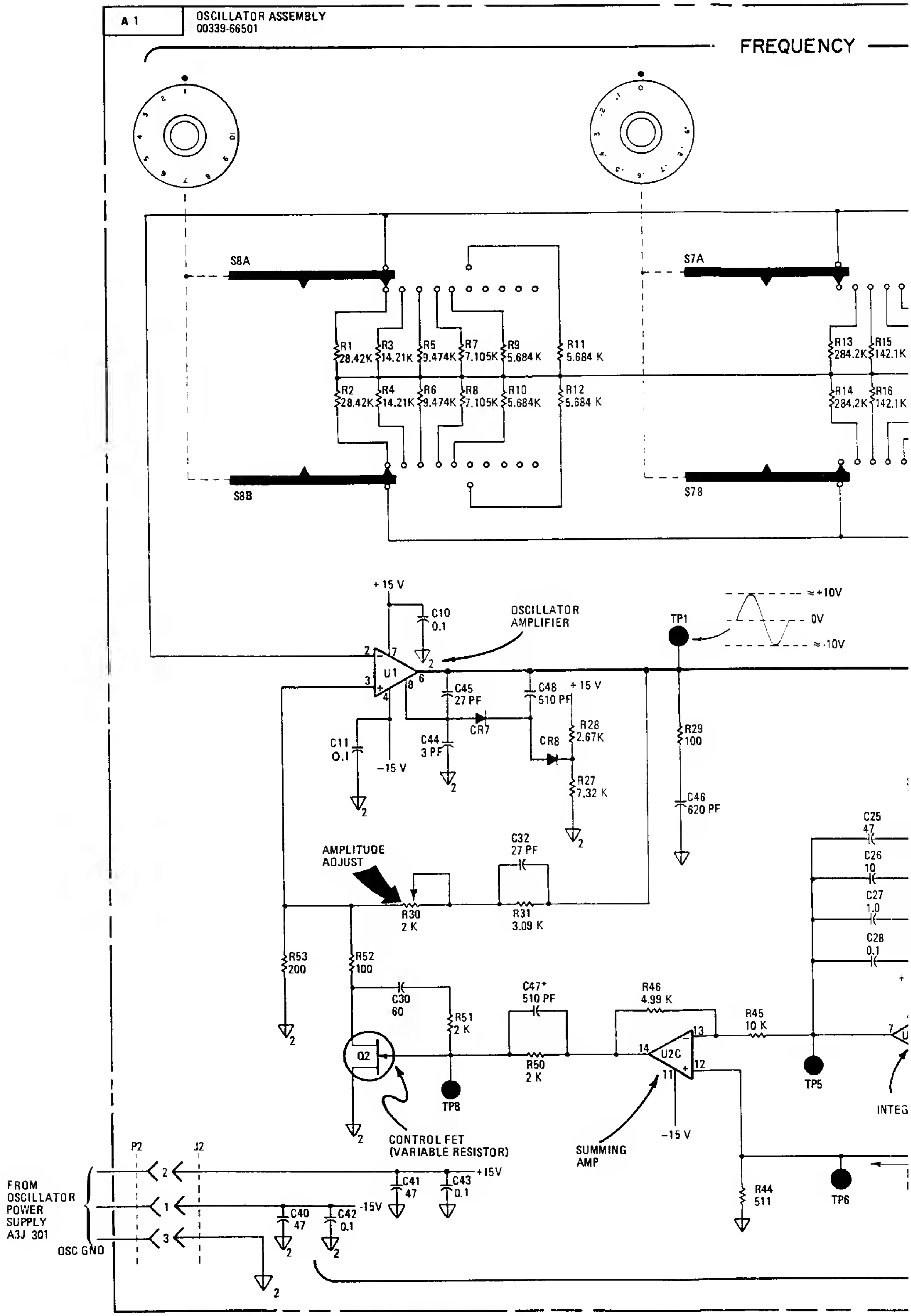
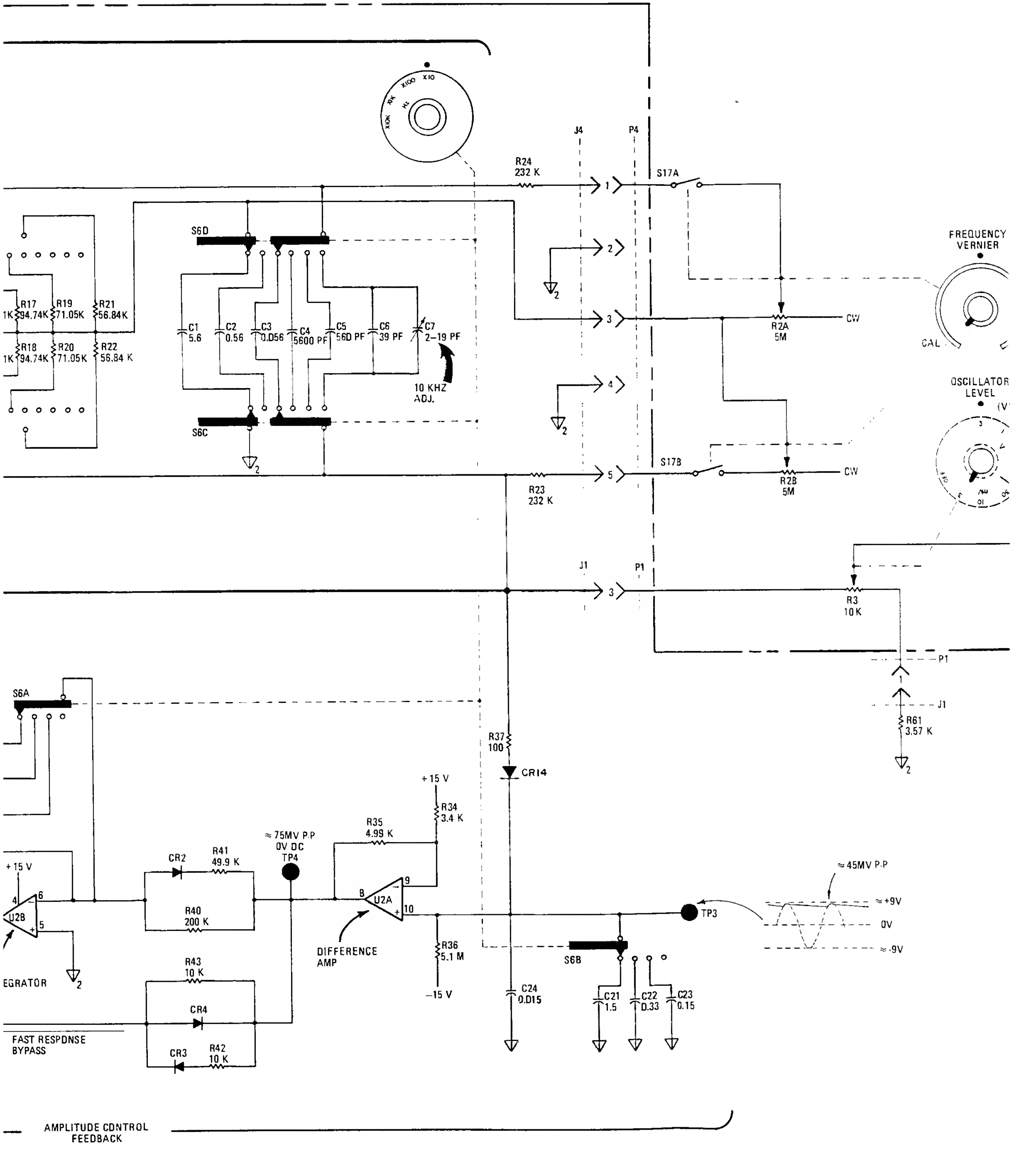


Figure 8-16. Auto Set-Level and Meter Circ
8-19/

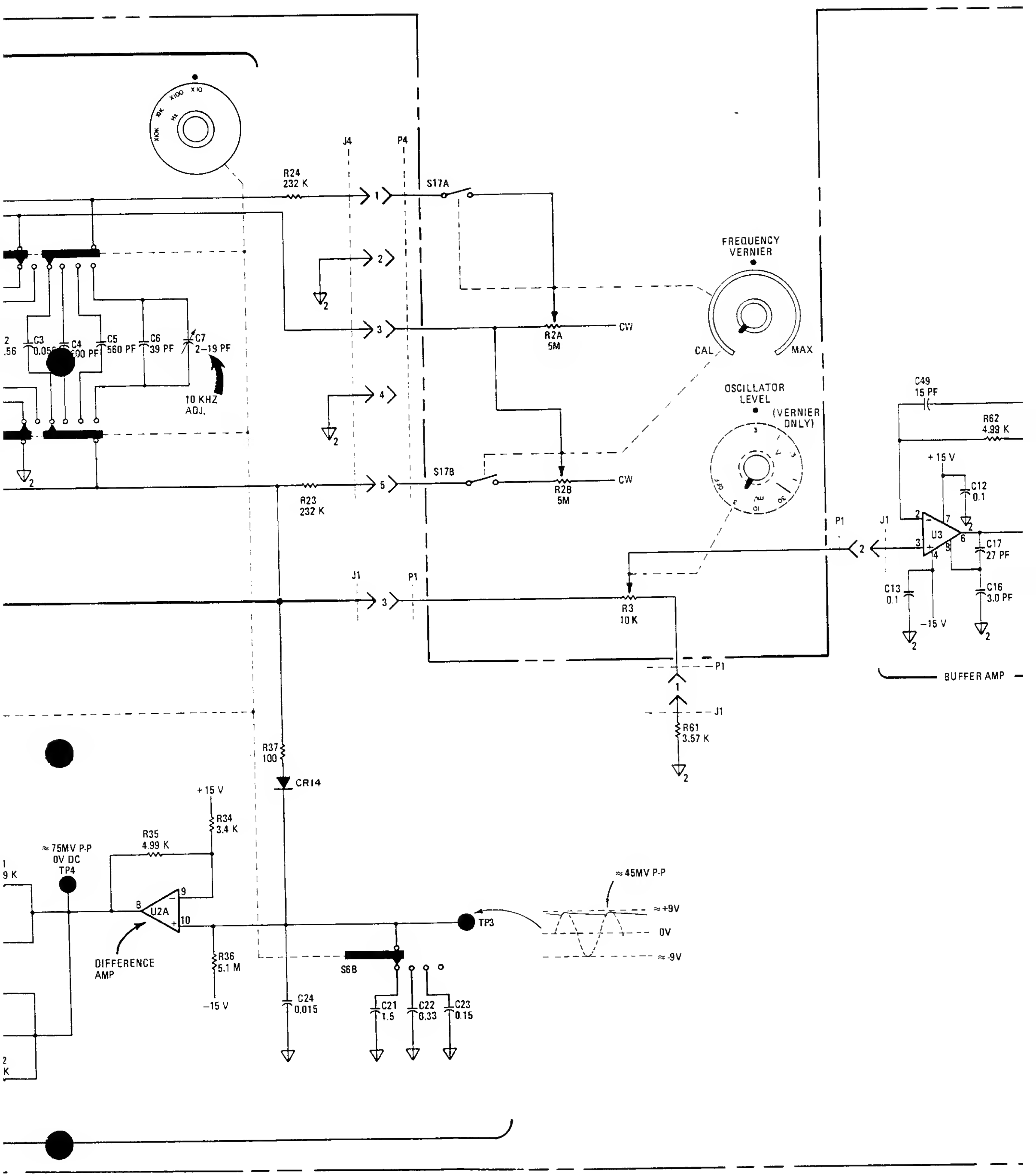


A1
00339-66501
Rev. D

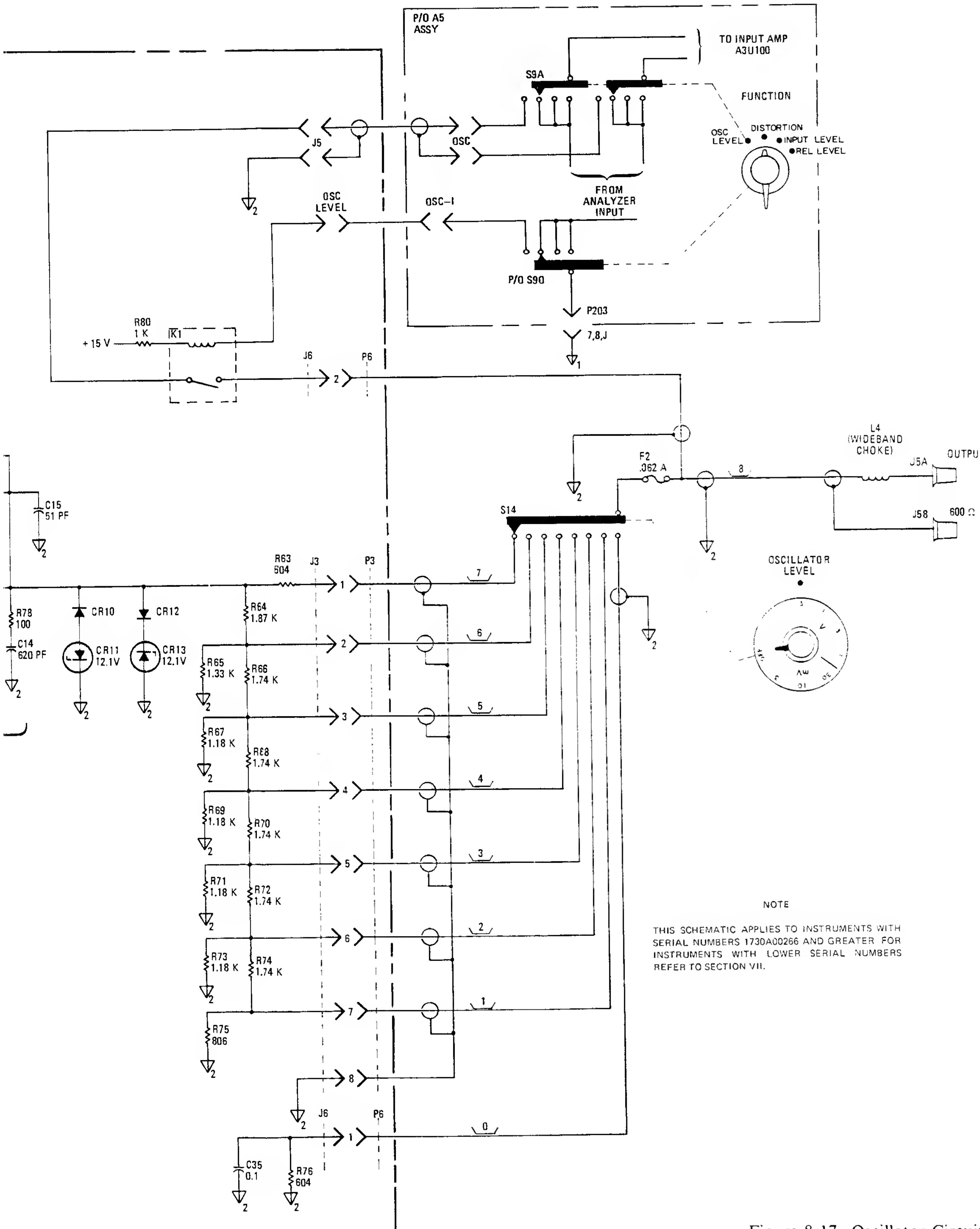

A 1
OSCILLATOR ASSEMBLY
00339-66501
FREQUENCY
S8A
S8B
S7A
S78
R1 28.42K
R3 14.21K
R5 9.474K
R7 7.105K
R9 5.684 K
R11 5.684 K
R2 28.42K
R4 14.21K
R6 9.474K
R8 7.105K
R10 5.684K
R12 5.684 K
R13 284.2K
R15 142.1K
R14 284.2K
R16 142.1K
+15 V
C10 0.1
OSCILLATOR AMPLIFIER
TP1
≈+10V
0V
≈-10V
U1
C45 27 PF
C48 510 PF
+15 V
CR7
R28 2.67K
CR8
C11 0.1
C44 3 PF
-15 V
R29 100
R27 7.32 K
C46 620 PF
C25 47
C26 10
C27 1.0
C28 0.1
AMPLITUDE ADJUST
C32 27 PF
R30 2 K
R31 3.09 K
R53 200
R52 100
C30 60
R51 2 K
C47* 510 PF
R46 4.99 K
R45 10 K
Q2
R50 2 K
U2C
TP5
TP8
INTEG
CONTROL FET (VARIABLE RESISTOR)
SUMMING AMP
-15 V
P2
J2
FROM OSCILLATOR POWER SUPPLY A3J 301
OSC GND
+15V
C41 47
C43 0.1
-15V
C40 47
C42 0.1
R44 511
TP6



X10
X100
10K
Hz
X1K
J4
P4
R24
232 K
S17A
S6D
FREQUENCY
VERNIER
R17
94.74K
R19
71.05K
R21
56.84K
C1
5.6
C2
0.56
C3
0.056
C4
5600 PF
C5
560 PF
C6
39 PF
C7
2–19 PF
R2A
5M
CW
CAL
R18
94.74K
R20
71.05K
R22
56.84 K
10 KHZ
ADJ.
OSCILLATOR
LEVEL
S6C
S17B
R2B
5M
CW
R23
232 K
J1
P1
R3
10 K
P1
J1
R61
3.57 K
S6A
R37
100
CR14
+15 V
R34
3.4 K
R35
4.99 K
≈ 75MV P-P
0V DC
TP4
≈ 45MV P-P
+15 V
CR2
R41
49.9 K
U2B
U2A
≈ +9V
0V
≈ -9V
TP3
R40
200 K
DIFFERENCE
AMP
R36
5.1 M
S6B
EGRATOR
R43
10 K
−15 V
C24
0.015
C21
1.5
C22
0.33
C23
0.15
CR4
FAST RESPONSE
BYPASS
CR3
R42
10 K
AMPLITUDE CONTROL
FEEDBACK



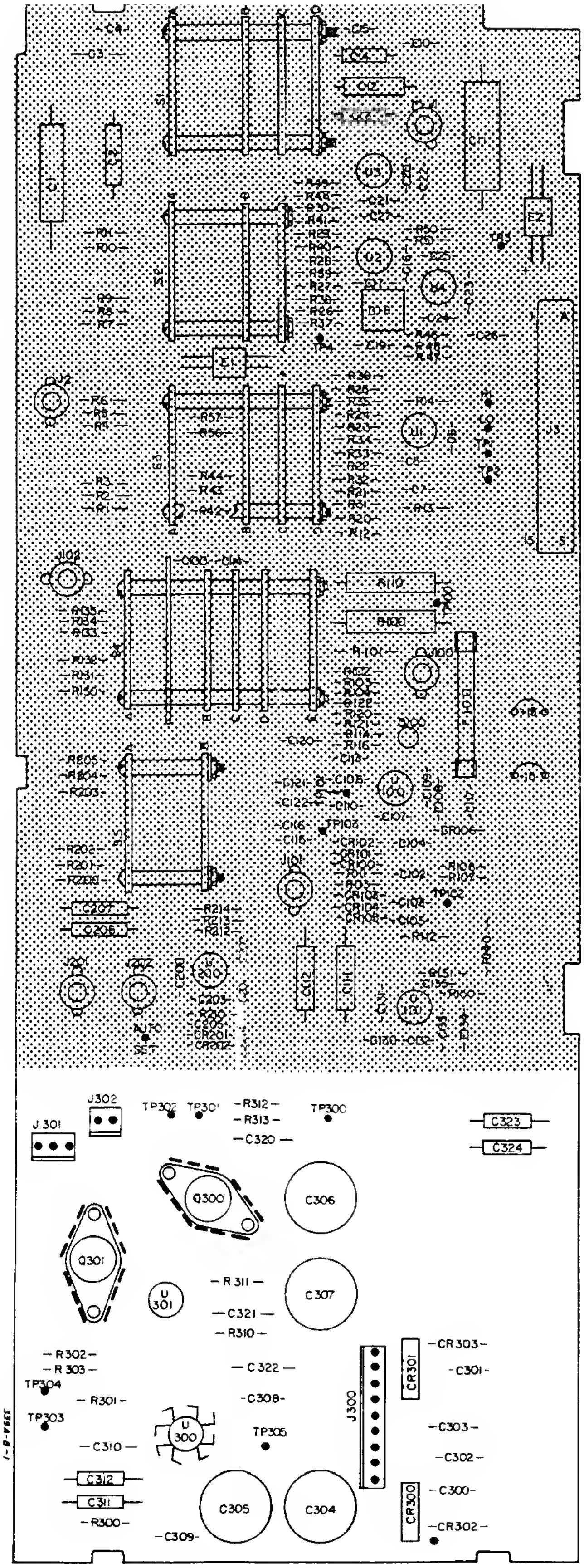
X10
X100
X1K
X10K
Hz
J4
P4
R24
232 K
S17A
FREQUENCY
VERNIER
CAL
MAX
CW
R2A
5M
C3
C4
C5
560 PF
C6
39 PF
C7
2–19 PF
10 KHZ
ADJ.
OSCILLATOR
LEVEL
(VERNIER
ONLY)
C49
15 PF
R62
4.99 K
+15 V
C12
0.1
S17B
R2B
5M
R23
232 K
J1
P1
R3
10 K
U3
C17
27 PF
C13
0.1
C16
3.0 PF
−15 V
BUFFER AMP
R61
3.57 K
R37
100
CR14
+15 V
R34
3.4 K
R35
4.99 K
≈ 75MV P-P
0V DC
TP4
U2A
DIFFERENCE
AMP
R36
5.1 M
−15 V
TP3
≈ 45MV P-P
≈ +9V
0V
≈ -9V
S6B
C24
0.015
C21
1.5
C22
0.33
C23
0.15



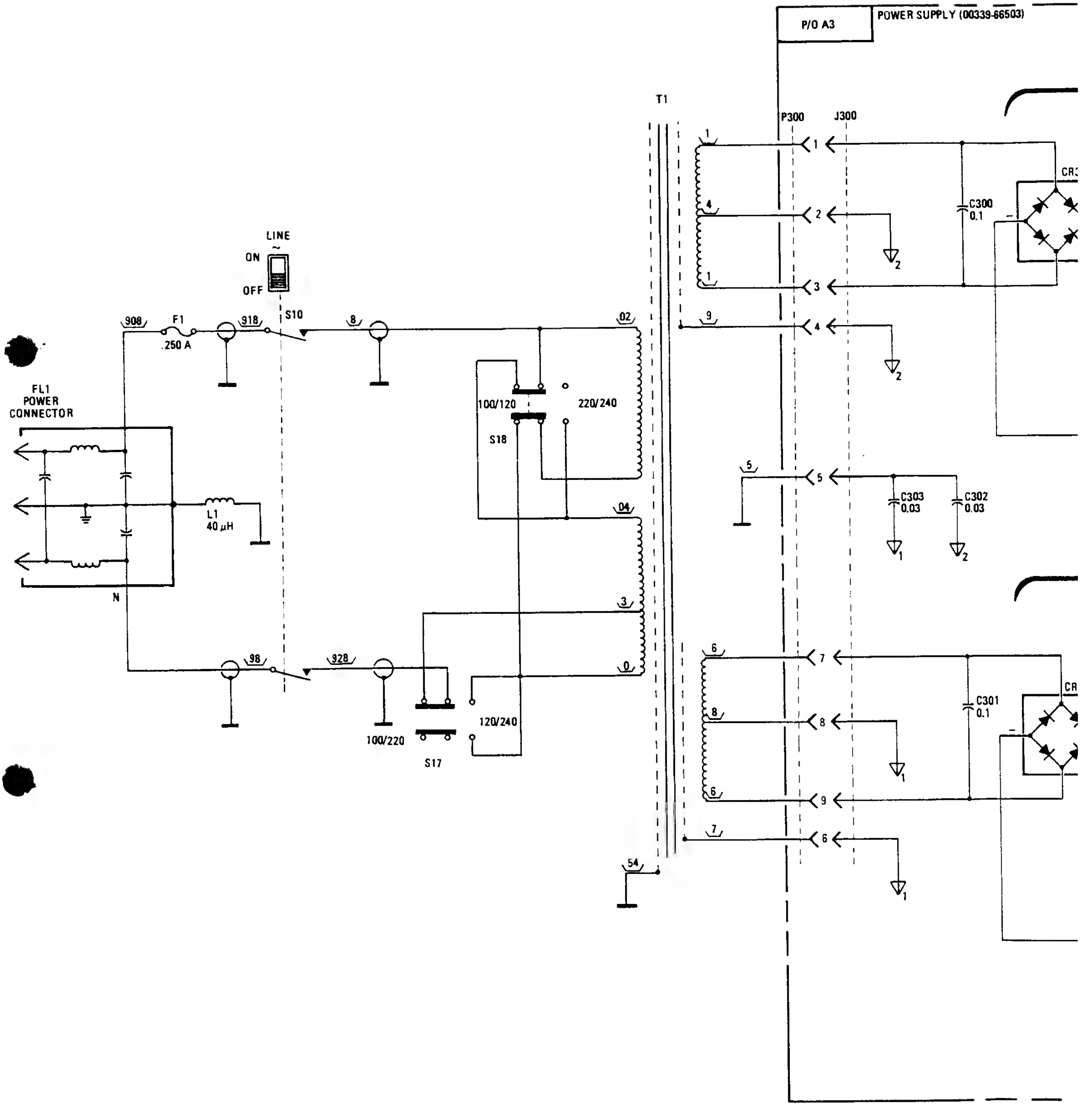
NOTE

THIS SCHEMATIC APPLIES TO INSTRUMENTS WITH SERIAL NUMBERS 1730A00266 AND GREATER FOR INSTRUMENTS WITH LOWER SERIAL NUMBERS REFER TO SECTION VII.

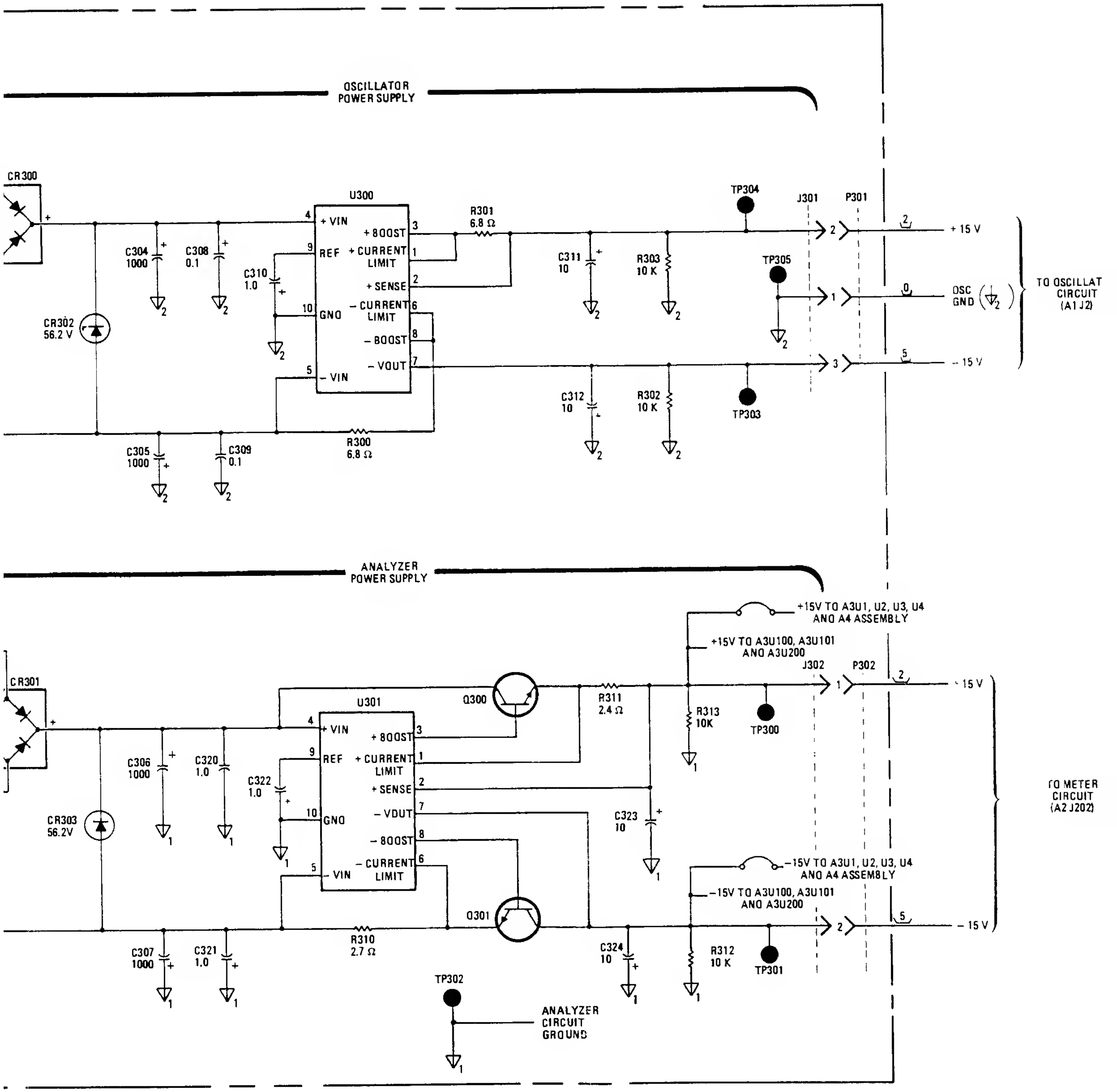
Figure 8-17. Oscillator Circuits.



A3
00339-66503
Rev. B



P/O A3
POWER SUPPLY (00339-66503)
T1
P300
J300
LINE
ON
OFF
S10
908
F1
.250 A
918
8
02
FL1
POWER
CONNECTOR
L1
40 µH
N
100/120
220/240
S18
04
3
0
98
928
100/220
120/240
S17
54
C300
0.1
C303
0.03
C302
0.03
C301
0.1



:KARD COMPANY

Figure 8-18. Power Suppli

MANUAL CHANGES

-hp- MODEL 339A

DISTORTION MEASUREMENT SET

Manual Part Number 00339-90001

▌ New or Revised Item

ERRATA.

Page 4-11, Figure 4-12. Change the part number of the SHIELD (item 7) from 1251-1073 to 1251-0173.

▌ **Page 4-11, Paragraph 4-25a.** The INPUT RANGE should be 0.1V, not 1V.

▌ **Page 4-12, Paragraph 4-26b.** The sentence should read, "Connect the equipment as shown in Figure 4-13 without the 100 kΩ series resistor."

8-11/8-12, Figure 8-12. Change the value of capacitor C1 from to .01 mfd.

CHANGE NO. 1 (applies to instruments with serial numbers 1730A00266 and greater).

Page 6-9, Table 6-3. Delete parts A4L3 and A4L4 -hp- part number 9170-0894.

Page 6-10, Table 6-3. Add the following parts:

A4R67	0757-0407	Resistor 200 Ω 1% .125 W
A4R68	0757-0407	Resistor 200 Ω 1% .125 W

Page 8-17, Figure 8-15. Delete parts L3 and L4 from the schematic. Add resistors R67 and R68 as shown in Figure 1.

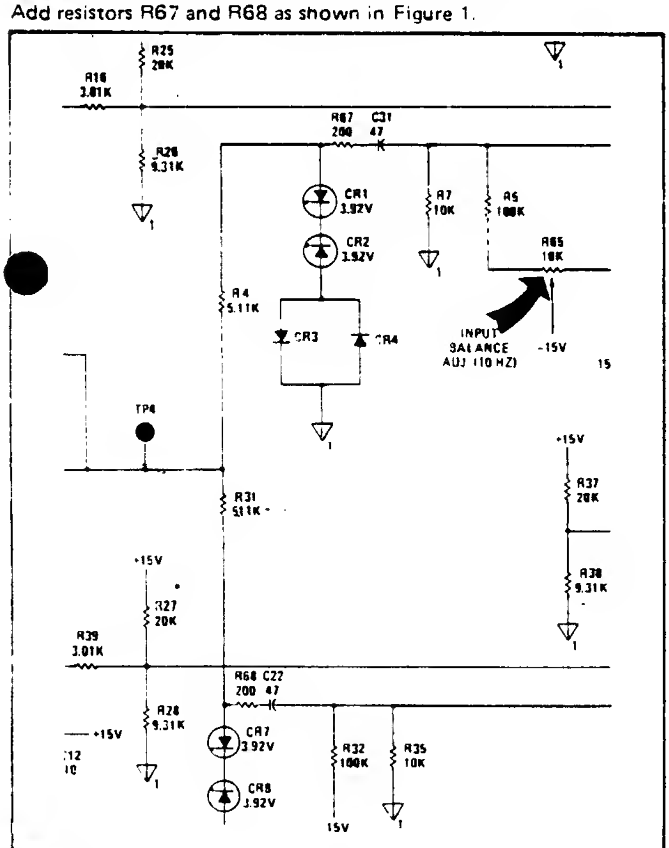


Figure 1.

Resistor R67 and R68 have replaced L3 and L4 for the prevention of high frequency oscillation.

CHANGE NO. 2 (applies to instruments with serial numbers 1730A00409 and greater).

Page 6-5, Table 6-3. Change A2R22 from 2100-0568 Resistor Trimmer 100 Ω 10% to 2100-3212 Resistor Trimmer 200 Ω 10%.

Page 6-6, Table 6-3. Add the following part:

A2R43 0757-0400 Resistor 90.9 Ω 1% .125 W TC=0+−100

Page 8-19/8-20, Figure 8-16. Change the value of resistor R22 from 100 Ω to 200 Ω on the schematic diagram. Add resistor R43 as shown in Figure 2.

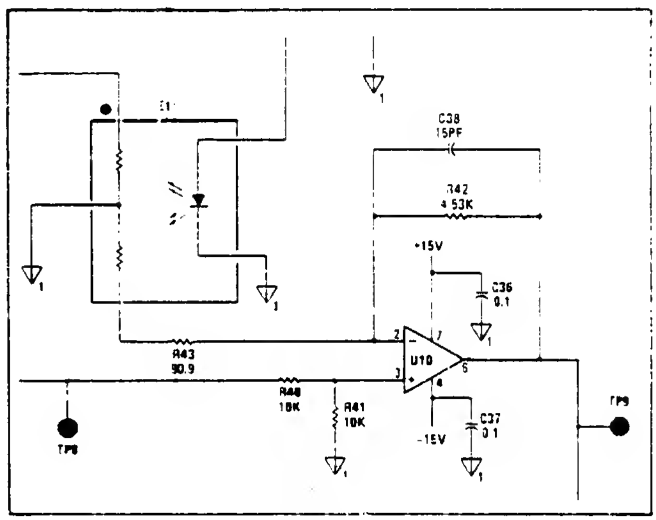


Figure 2.

Resistor R43 has been added and the value of R22 has been changed to compensate for possible tracking errors of the photo-resistors in photo-module E1

NOTE

Not all replacement photo-modules will work properly in instruments which do not have this modification.

CHANGE NO. 3 (applies to all instruments).

Page 6-8, Table 6-3. Change R113 to *R113 (selected component). Add the following padding list for *R113:

0757-0442	Resistor 10 K	1%	.125 W F TC = 0 ± 100
0757-0449	Resistor 20 K	1%	.125 W F TC = 0 ± 100
0757-0453	Resistor 30.1 K	1%	.125 W F TC = 0 ± 100
0698-3499	Resistor 40.2 K	1%	.125 W F TC = 0 ± 100

Page 8-13/8-14, Figure 8-13. Change R113 to *R113 and change the nominal value from 10 kΩ to 30.1 kΩ on the schematic diagram.

This change has been made to permit compensation for differences in the dynamic characteristics of FET's used for Q100. The value of *R113 is selected to minimize distortion introduced by the input amplifier stage.

CHANGE NO. 4 (applies to all instruments).

Page 6-10, Table 6-3. Change A4R23 from 0698-3445 Resistor 348 Ω 1% to 0698-4450 Resistor 324 Ω 1%. Change A4R55 from 0698-4453 Resistor 402 Ω 1% to 0698-3445 Resistor 348 Ω 1%.

Page 8-17, Figure 8-15. Change the value of R23 from 348 Ω to 324 Ω and the value of R55 from 402 Ω to 348 Ω on the schematic diagram.

These changes have been made to insure that the proper current is available to drive photo-modules A3E1 and A3E2.

CHANGE NO. 5 (applies to instruments with serial numbers 1730A00451 and greater).

Page 6-7, Table 6-3. Change capacitor A3C302 from [illegible]0-2628 (.03 mfd.) to 0150-0052 (.05 mfd).

Page 6-6, Table 6-3. Add the following resistor:

A3R314 0683-1035 Resistor 10 kΩ 5% 1/4 W

Page 8-23/8-24. Change the Power Supply schematic diagram as shown in Figure 3.

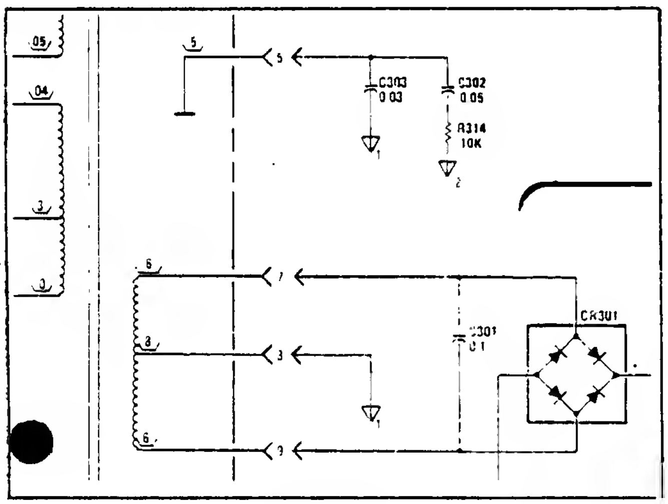


Figure 3.

CHANGE NO. 6 (applies to all instruments).

Page 6-10, Table 6-3. Change the part number and value of A4R59 from 0757-0407, 200Ω to 0757-0410, 301Ω. Change the part number and value of reference designator A4R60 from 0757-0407, 200Ω to 0757-0401, 100Ω.

Page 8-17, Figure 8-15. Change the schematic value of R59 from 200Ω to 301Ω and the value of R60 from 200Ω to 100Ω. Change the voltage level at the junction of R59 and and R60 from +0.7 to +0.5 volts.

This change establishes a new reference for A4U6C to insure that the "HI" frequency indicator is extinguished when the proper range is selected.

NOTE

If it is necessary to change photo-module A3E1 be certain that A4R59 and A4R60 are the new values listed in this change.

CHANGE NO. 7. (applies to all instruments.)

Page 1-2, Table 1-1. Changed Fundamental Rejection specification for frequency range 50KHz to 110 KHz from >86 dB to >83 dB

Page 4-10, Table 4-6. Change table as shown.

Table 4-6. Fundamental Rejection and Induced Distortion Test

Test Frequency	Fundamental Rejection Specification	Induced Distortion Specification
10 Hz 100 Hz 1kHz 10kHz 20 kHz	>-100 dB	>-95 dB
30kHz		>-90 dB
50kHz	>-90 dB	>-85 dB
110kHz	>-83 dB	>-70 dB

Page 4-16. Change "Fundamental Rejection and Induced Destortion Test" form as shown.

Fundamental Rejection and Induced Distortion Test:

Test Frequency	339A Fundamental Rejection	Test Limit	339 Induced Distortion	Test Limit
10Hz	________		________	
100Hz	________		________	
1kHz	________	-100 dB	________	-95 dB
10kHz	________		________	
20kHz	________		________	
30kHz	________		________	-90 dB
50kHz	________	-90 dB	________	-85 dB
110 kHz	________	-83 dB	________	70 dB

CHANGE NO. 8 (applies to all instruments).

Page 6-14, Table 6-3. Change miscellaneous part MP12 part number to 00339-04111. Change miscellaneous part MP13 part number to 00339-04102. Add part number 5041-3155, quantity 10, description "SHAFT EXTENDER"

CHANGE NO. 9 (applies to all instruments).

Page 6-9, Table 6-3. Change the part number of A4C25 from 0180-2338 to 0180-2927. The new part is the same value but with a leakage specification of 0.6 uA maximum after 2 minutes @ 9 VDC.

CHANGE NO. 10 (applies to all instruments).

Page 6-3, Table 6-3. Add the following list of part numbers and values to A1C47*:

0160-0356	CAPACITOR-FXD 18pF
0160-2306	CAPACITOR-FXD 27pF
0160-0204	CAPACITOR-FXD 47pF
0160-0376	CAPACITOR-FXD 68pF
0140-0193	CAPACITOR-FXD 82pF
0140-0194	CAPACITOR-FXD 110pF
0140-0198	CAPACITOR-FXD 200pF

Note that the value most often installed by the factory will be 200pF. The other values are possible alternatives. Selection of this value will optimize the high frequency (> 100kHz) distortion.

Page 8-21/8-22, Figure 8-17. Change the value listed on the schematic for C47* from 510pF to 200pF.

CHANGE NO. 11 (effective on serial numbers 1730A01162 to 1730A01958).

Page 6-9, Table 6-3. Add A4C32* and the following list of part numbers and values:

0160-2248	CAPACITOR-FXD 4.3pF
0160-2249	CAPACITOR-FXD 4.7pF
0160-2250	CAPACITOR-FXD 5.1pF
0160-2251	CAPACITOR-FXD 5.6pF
0160-2252	CAPACITOR-FXD 6.2pF

Note that the value most often installed by the factory will be 5.1pF. The other values are possible alternatives.

Page 8-17, Figure 8-15. Add capacitor C32* in parallel with R2. The value of C32* should be listed as 5.1pF.

This addition will provide phase shift at 110 kHz which will improve the fundamental rejection at that frequency.

(applies to all instruments)
(effective on serial number 1730A01958 and above)

The installed value for C32* is 6.2pF. Since the above list already includes this value a schematic change is all that is necessary.

CHANGE NO. 12 (applies to all instruments)
(effective on serial number 1730A00596 and above).

Page 6-5, Table 6-3. Change the part number of A2C23 from 0180-1746 to 0180-2944. The new part is the same value but has a leakage specification of 0 05 uA maximum @ 14 VDC.

C23 is used to slow the response time of the rms detector U5, which consequently slows the meter response in the NORMAL mode. In the VU mode C23 is switched out of the circuit. If the dc leakage through C23 exceeds .05uA a dc voltage offset occurs at pin 4 of U5 causing an erroneous meter reading.

Page 6-7, Table 6-3. Change the part number and value of A3C324 from 0180-0374, 10uF to 0180-0374, 15uF.

Page 8-23/8-24, Figure 8-18. Change the schematic value of C324 from 10uF to 15uF.

Raising the value of this capacitor will lower the ac impedance of the -15V power supply to the A2 board. This will improve the operation of the 80 kHz filter.

CHANGE NO. 13 (applies to all instruments) (effective on Serial Number 1730A00776 and above).

Page 6-3, Table 6-3. Change the part number and value of A1C21 from 0180-1745, 1.5uF to 0180-0197, 2.2uF.

Page 8-21/8-22, Figure 8-17. Change the schematic value of C21 from 1.0uF to 2.2uF.

This change reduces the 10Hz ripple in the amplitude control circuits. A large ripple voltage at TP4 can cause CR4 to turn on which causes harmonic distortion.

Page 6-5, Table 6-3. Delete all information on A2C21.

Page 8-19/8-20, Figure 8-16. Delete C21 from the schematic.

This part has been deleted because the newer rms detectors (A2U5) do not require its use.

(effective on serial numbers 1730A00776 to 2025A02646)

Page 6-4, Table 6-3. Change the part number and value of A2C13 from 0160-2244, 3pF to 0160-2236, 1pF.

Page 8-19/8-20, Figure 8-16. Change the schematic value of C13 from 3pF to 1pF.

This change has come about to increase the bandwidth of A2U4. The old rms detector, A2U5, had a peak in the response at 110kHz which compensated for the reduced bandwidth of A2U4. The new detectors (marked AD536AJ) don't have this peak in their frequency response.

(applies to all instruments)
(effective on serial numbers 2025A02646 and above)

Page 6-4, Table 6-3. Delete all information on reference designators A2C11 and A2C13.

Page 8-19/8-20, Figure 8-16. Delete schematic symbols, values, and designators for C11 and C13.

(effective on serial numbers 1730A00776 to 2025A02226)

Page 6-6, Table 6-3. Change the part number and value for A3C114 from 0160-0363, 620pF to 0160-2209, 360pF.

Page 8-13/8-14, Figure 8-13. Change the schematic value of C114 from 620pF to 360pF.

(applies to all instruments)
(effective on serial number 2025A02226 and above)

Page 6-6, Table 6-3. Change the part number and value of reference designator A3C114 from 0160-2209, 360 pF to 0160-0341, 640pF.

Page 8-13/8-14 Figure 8-13. Change the schematic value of C114 from 360pF to 640pF.

CHANGE NO. 14 (applies to all instruments)
(effective on serial number 1730A00844 and above).

Page 6-10, Table 6-3. Change the part number and value for A4R48 and A4R52 from 0698-4435, 2.49kΩ to 0698-3515, 5.9kΩ.

Page 6-17, Figure 8-15. Change the schematic values of R48 and R52 from 2.49kΩ to 5.9kΩ.

This change is being done to decrease the lock-in time of the notch. Low level 120Hz line signals could beat with the fundamental when the 339 is tuned to 100Hz causing "out of specification" distortion readings at 100Hz.

CHANGE NO. 15 (applies to all instruments)
(effective on serial number 1730A00916 and above).

Page 6-8, Table 6-3. Change the part number and value of A3C132* from 0160-2249, 4.7pF to the following list:

0160-2251	CAPACITOR-FXD 5.6pF
0160-2253	CAPACITOR-FXD 6.8pF
0160-2254	CAPACITOR-FXD 7.5pF
0160-2255	CAPACITOR-FXD 8.2pF
0160-2256	CAPACITOR-FXD 9.1pF
0160-2257	CAPACITOR-FXD 10pF
0160-2259	CAPACITOR-FXD 12pF
0160-2261	CAPACITOR-FXD 15pF

Note that the value most often installed by the factory is 10pF. This change is to prevent U101 from oscillating.

Page 8-13/8-14, Figure 8-13. Change the schematic value of C132* from 4.7pF to 10pF.

The two gates of Q100 should be connected to pin 3 of U100 instead of pin 2 as shown. On the schematic break the line between the gates common point and the feedback loop of U100 and draw a new line straight down to TP101 and pin 3 of U100.

Source-follower Q100 keeps the voltage across the input protection diodes constant. Prior to this change the bootstrap voltage came from the feedback network of U100 (pin 2) rather than the input signal, causing distortion at higher frequencies due to the delay in the feedback signal.

CHANGE NO. 16 (effective on serial numbers 1730A00916 to 1730A02436).

Page 6-8, Table 6-3. Add A3R60, part number 2100-3210, value 10KΩ.

Page 8-15/8-16, Figure 8-14. Add R60, a 10k variable resistor, in series with A3E1 photoresistor.

(applies to all instruments)
(effective on serial number 1730A02436 and above)

Page 6-8, Table 6-3. Delete all information on A3R60.

Page 8-15/8-16, Figure 8-14. Remove R60 and replace with a wire jumper.

This was installed to insure that phase control (which runs the error lights) would not pull down to as low a bridge resistance as the amplitude control and the LO frequency lamp always lights to signal when the frequency is too low. It was later removed because it was seldom used.

CHANGE NO. 17 (applies to all instruments) (effective on serial numbers 1730A00850 to 1730A00858 and 1730A00986 and above).

Page 6-6, Table 6-3. Add reference designator A3C28, part number 0160-2264, value 20pF.

Page 6-8, Table 6-3. Change the part number and value for the following reference designators:

A3R42	from 0698-3161 38.3kΩ	to 0757-0454 33.2kΩ
A3R43	from 0757-0451 24.3kΩ	to 0698-3158 23.7kΩ
A3R48	from 0757-0446 15kΩ	to 0757-0452 27.4kΩ
A3R49	from 0698-3152 3.48kΩ	to 0757-0439 6.81kΩ

Page 8-15/8-16, Figure 8-14. Change the schematic values of the resistors above as shown. Add C28, value 20pF in parallel with R49.

The addition of C28 and the change in value of R49 is to eliminate a 5MHz oscillation in A3U3. The other resistor changes allow the photocells A3E1 and A3E2 to pull the notch in through a wider range of frequencies. Prior to this change, photocells which met specifications but were at the limits would not work.

CHANGE NO. 18 (applies to all instruments)
(effective on serial number 1730A01488 and above)

Page 6-12, Table 6-3. Change the part number of reference designator F2 from 2110-0384 to 2110-0612.

The old fuse caused 3rd order harmonic distortion at low frequencies due to its thermal properties.

CHANGE NO. 19 (effective on on serial numbers 1730A01758 to 2025A03427)

Page 6-8, Table 6-3. Change the part number and value of A3C100 from 0160-2251, 5.6pF to 0140-0209, 5pF.

Page 8-13/8-14, Figure 8-13. Change the value of C100 from 5.6pF to 5pF.

This change eliminates the possibility of a short from 10V to ground.

(applies to all instruments)
(effective on serial number 2025A03427 and above)

Page 6-6, Table 6-3. Change the part number and value of A3C100 from 0140-0209, 5pF to 0160-2244, 3pF.

Page 8-13/8-14, Figure 8-13. Change the value of C100 from 5pF to 3pF.

CHANGE NO. 20 (applies to all instruments)
(effective on serial number 2025A02226 and above)

Page 6-6, Table 6-3. Change the part number and value of the following reference designators as shown below:

A3C115	from 0160-2263 18pF	to 0140-0190 39pF
A3C116	from 0140-0195 130pF	to 0160-0134 220pF

Page 8-13/8-14, Figure 8-13. Change the value of C115 from 18pF to 39pF and of C116 from 130pF to 220pF.

Page 6-5, Table 6-3. Add A2C50 and A2C51 whose part numbers are 0160-4571 and values are .1uF.

Page 6-6, Table 6-3. Add reference designators A2R50 and A2R51 whose part numbers are 0757-0401 and values are 100Ω.

Page 8-19/8-20, Figure 8-16. Add R50, R51, C50, and C51 to the schematic as shown in Figure 4.

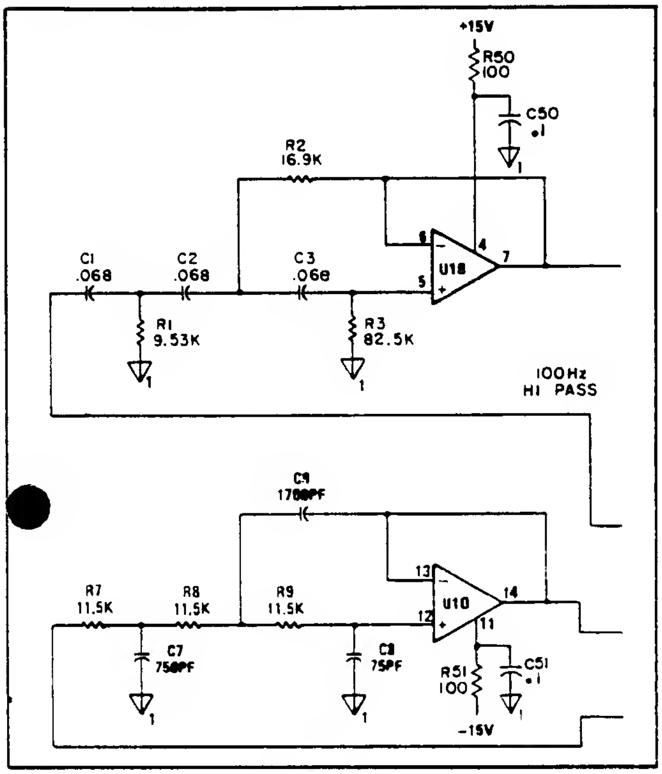


Figure 4

This change is to decouple power supplies on A2U1 to reduce the affect of internal oscillation on the 80kHz filter response. The values of C114, C115 and C116 are changed to compensate for the stray capacitance in the new 00339-26513 printed circuit board. (See change no. 13 for information on C114).

(effective on on serial number 2025A02226 to 2025A02436)

Page 8-9, Table 8-3. Change the part number of A3U200 from 1826-0109 to 1826-0413.

(effective from serial number 2025A02226 to 2025A02788)

Page 6-7, Table 6-3. Change the part number and value of A3C205 from 0160-2264, 20pF to 0160-2200, 43pF.

Page 8-15/8-18, Figure 8-14. Change the value of C205 from 20pF to 43pF.

(effective on serial number 2025A02436 to 2025A02786)

Page 6-9, Table 8-3. Change the part number for A3U200 from 1826-0413 to 1826-0081.

(applies to all instruments)
(effective on serial number 2025A02786 and above)

Page 6-9, Table 6-3. Change the part number for A3U200 from 1826-0081 to 1826-0413.

Page 6-7, Table 6-3. Change the part number and value of A3C205 from 0160-2200, 43pF to 0160-2198, 20pF.

Page 8-15/8-16, Figure 8-14. Change the value of C205 from 43pF to 20pF.

These chenges reduce noise in the Analyzer Mode due to the LM-318 Op Amp. Meter reedings at 1kHz with a clean source are typically -94dB. With the HA 2605 the meter typically reads -96dB.

CHANGE NO. 21 (applies to all instruments)
(effective on serial number 2022A02156 and above).

Page 6-14, Table 6-3. Change the pert numbers for the following miscellaneous parts:

MP9 from 00339-00603 to 00339-00613
MP10 from 00339-00601 to 00339-00611
MP11 from 00339-00602 to 00339-00612
MP14 from 00339-00604 to 00339-00614
MP15 from 00339-00605 to 00339-00615

(effective on SN 1730A02156 and above)

Page 6-13, Table 6-3. Add part number 00339-23201, Qty 5, Coupler, Shaft.

CHANGE NO. 22 (applies to all instruments)
(effective on serial number 2025A02296 and above).

Page 6-4, Table 6-3. Change the part number of A1U2 from 1826-0315 to 1826-0557.

Page 6-6, Table 8-3. Change the part number of A2U8 from 1826-0315 to 1826-0557.

Page 6-7, Table 8-3. Delete all information on A3J2.

Page 6-10, Table 6-3. Change the part number of A4U3, A4U5, and A4U6 from 1826-0315 to 1826-0557.

(effective on serial numbers 1730A02156 to 2025A03716)

Page 6-8, Table 8-3. Change the part number for A2U1 from 1826-0315 to 1826-0557.

The change of IC part numbers is to a ceramic part to prevent field failures due to phosphorus contamination.

(applies to all instruments)
(effective on Serial Number 2025A03718 and above)

Page 6-6, Table 8-3. Change the part number of A2U1 from 1826-0557 to 1826-0323.

CHANGE NO. 23 (applies to all instruments)
(effective on serial number 2025A02366 and above).

Page 6-11, Table 6-3. Add part number 00339-00616, "SHIELD, PCB".

CHANGE NO. 24 (applies to all instruments)
(effective on serial number 1730A02438 and above).

Page 6-7, Table 8-3. Change the part number and value for A3F100 from 2110-0011, .062A to 2110-0236, .1A.

Page 8-13/8-14, Figure 8-13. Change the value of F100 from .062A to .1A.

CHANGE NO. 25 (effective on serial numbers 2025A02436 to 2025A02786).

Page 6-7, Table 6-3. Delete all information on A3C202, A3C203, A3C204, A3CR200, and A3CR201.

Page 8-15/8-16, Figure 8-14. Delete schematic symbols, values, and designators for C202, C203, C204, CR200, and CR201.

(applies to all instruments)
(effective on serial number 2025A02786 and above)

Page 6-7, Table 6-3. Add the following reference designators, part numbers, and values:

A3C204 0160-2201 51pF
A3CR200 1901-0040 Diode
A3CR201 1901-0040 Diode

Page 6-15/8-16, Figure 6-14. Replace C204, CR200 and CR201 where they were in the schematic originally.

The end result is to delete C202 and C203.

CHANGE NO. 26 (applies to all instruments).

Page 6-13, Table 6-3. Change the description of part number 00339-04004 from "KNOB, TENS" to "KNOB, UNITS". Change the description of part number 00339-04005 from "KNOB, UNITS" to "KNOB, TENS".

CHANGE NO. 27 (applies to all instruments)
(effective on serial number 1730A02716 and above).

Page 6-12, Table 6-3. Just above the listing of W4 add part number 00339-61915, "SWITCH ASSY." and move the reference designator W4 up to the new listing. Just above the listing of W5 add part number 00339-61916, "SWITCH ASSY." and move the reference designator W5 up to the new listing.

Page 6-13, Table 6-3. Just above the listing of W10 add part number 00339-61917, "SWITCH ASSY." and move the reference designator W10 up to the new listing.

CHANGE NO. 28 (effective on serial numbers 2025A02646 to 2025A03716).

Page 6-4, Table 6-3. Change the part number and value of the reference designators below as listed:

A2C4 from 0160-0341 640pF to 0160-2940 470pF
A2C5 from 0160-2201 51pF to 0140-0192 68pF

Page 6-19/8-20, Figure 8-16. Change the value of C4 from 640pF to 470pF and that of C5 from 51pF to 68pF.

(applies to all instruments)
(effective on serial number 2025A03716 and above)

Page 6-4, Table 6-3. Change the part number and value of the reference designators below as listed:

A2C4 0160-2940 470pF to 0140-0234 500pF
A2C5 0140-0192 68pF to 0160-3083 62pF

Page 6-19/8-20, Figure 6-16. Change the value of C4 from 470pF to 500pF and that of C5 from 68pF to 62pF.

This change improves, 1)gain above 100kHz, and 2)80kHz filter response. Changing A2R6 is part of this update. See change no. 29.

(applies to all instruments)
(effective on serial number 2025A02646 and above)

Page 6-4, Table 6-3. Change the part number and value of A2C15 from 0160-2201 51pF to 0160-2204 100pF.

Page 8-19/8-20, Figure 8-16. Change the value of C15 from 51pF to 100pF.

Page 6-13, Table 6-3. Change the part numbers and descriptions of the following items:

from 2110-0465 to 2110-0564 FUSEHOLDER
from 2110-0467 to 2110-0565 CAP, FUSEHOLDER
from 2110-0470 to 2110-0569 NUT, FUSEHOLDER

CHANGE NO. 29 (applies to all instruments)
(effective on serial number 2025A03716 and above).

Page 6-13, Table 6-3. Change the part number of W7 from 00339-61607 to 00339-61612 and that of W7S10 from 3101-1656 to 3101-2216. The description for W7S10 should read "SWITCH POWER". Below that listing delete all information on part number 5040-5932 and add 8120-0593, "CABLE SHIELD".

Page 6-14, Table 6-3. Change the part number of MP1 from 00339-00201 to 00339-00211 and that of MP2 from 00339-00202 to 00339-00212.

Page 6-5, Table 6-3. Change the part number and value for A2R6 from 0698-4445, 5.76kΩ to 0698-3382, 5.49kΩ.

Page 8-19/8-20, Figure 8-16. Change the value of R6 from 5.76kΩ to 5.49kΩ.

This is part of the change to improve, 1)gain above 100kHz, and 2) 80kHz filter response. See change no. 28.

CHANGE NO. 30 (applies to all instruments)
(effective on serial number 2025A03786 and above).

Page 6-11, Table 6-3. Change the part number 3100-3423 to 3100-1663.

When PN 3100-3423 went from hill-and-valley to a unidex indexer it was necessary to change part numbers. The new and old PNs are completely interchangeable.

CHANGE NO. 31 (applies to all instruments)
(effective on serial number 2025A02716 and above).

Page 6-6, Table 6-3. Change the part number and value of A3C110 from 0140-0192, 68pF to 0140-0190, 39pF

Page 6-9, Table 6-3. Add cable assy 00339-61613 at the end of the listings for the A3 board.

Page 8-13/6-14, Figure 8-13. Change the value of C110 from 68pF to 39pF.

These changes improve range-to-range accuracy.

Page 6-14, Table 6-3. Add part number 5041-3124, PUSH ROD.

CHANGE NO. 32 (applies to all instruments).

Page 6-7, Table 6-3. Change the part number of A3Q100 from 1855-0360 to 1855-0458.

This change is being made because PN 1855-0360 is being discontinued by the vendor.

Page 6-6, Table 6-3. Add "SOCKET, 14 PIN IC", part number 1200-0638 to the repleceeble perts list at the end of the listings for the A2 boerd.

Page 6-5, Table 6-3. Add "HOLD DOWN SPRING", part number 1460-1581 to the repleceable parts list after the listing of A2K1.

Prior to this change this part could only be ordered as part of the relay.

CHANGE NO. 33 (applies to all instruments)
(effective on serial number 2025A03571 and above).

Page 6-10, Table 6-3. Change the part number of A4U2 and A4U4 from 1820-0427 to 1826-0934.

A seperate PN for Signetics part was established because PN 1820-0427 will no longer give the fundamental rejection required by the 339A.

CHANGE NO. 34 (applies to all instruments).

Page 6-6, Table 6-3. Change the part number of A3C16 and A3C17 from 0160-3622 to 0150-0084. The value does not change.

Change the part number and value of A2R35 from 2100-0567, 2kΩ to 2100-3252, 5kΩ.

CHANGE NO. 35 (applies to all instruments).

Page 6-3, Table 6-3. Change the part number of A1 from 00339-66501 to 00339-66511.

Page 6-4, Table 6-3. Change the part numbers of the components listed below:

A1S6 from 00339-61902 to 00339-61906
A1S7 from 00339-61903 to 00339-61907
A1S8 from 00339-61904 to 00339-61908
A2 from 00339-66502 to 00339-66512

Add to the description of part number 3100-3421 (under A1S6) "MULTIPLIER". Change the description of A1S7 from "UNITS" to "TENTHS" Add to the description of part number 3100-3422 (under A1S7) "TENTHS". Change the description of A1S8 from "TENTHS" to "UNITS".

Page 6-6, Table 6-3. Change the part number of A3 from 00339-66503 to 00339-66513.

Page 6-9, Table 6-3. Change the part numbers of the components listed below:

A3S1 from 00339-61905 to 00339-61901
A3S2 from 00339-61906 to 00339-61902
A3S3 from 00339-61907 to 00339-61903
A3S4 from 00339-61908 to 00339-61904
A3S5 from 00339-61909 to 00339-61905

Page 6-11, Table 6-3. Change the part number for A5S9 from 00339-61901 to 00339-61909.

Page 6-13, Table 6-3. Delete the part number 0370-2990 KNOB, RND W/BAR.

Page 6-14, Table 6-3. Change the part number of MP16 from 00339-00606 to 00339-00616. Add the part number 5041-0531, KEY CAP.

CHANGE NO. 36 (applies to all instruments)
(effective on serial number 1730A01956 and above).

Page 6-9, Table 6-3. Change the part number and velue of A4R2 from 0757-0472, 200kΩ to 0698-4211, 158kΩ.

At the bottom of the page, change the note to read "with serial numbers 1730A00196 to 1730A00266."

Page 8-17, Figure 8-15. Change the value of R2 (feedback on U1) from 200k to 158k.

Page 6-10, Table 6-3. Change the following part numbers and values:

A4R21 from 0698-4486 24.9k to 0698-3243 178k
A4R22 from 0698-4486 24.9k to 0698-3243 178k
A4R49 from 0757-0447 16.2k to 0698-3228 49.9k
A4R51 from 0757-0447 16.2k to 0698-3228 49.9k
A4R53 from 0757-0280 1.0k to 0757-0273 3.01k

Page 6-17, Figure 6-15. Change the values on the schematic as listed above.

These changes were made to reduces internally generated 2nd harmonic distortion. These changes slow down the 339A response as shown below:

Frequency	Pull-in Time	
	Before Change	After Change
10Hz	10 sec.	12 sec.
1Hz	4 sec.	9 sec.
100kHz	3 sec.	6 sec.

CHANGE NO. 37 (applies to all instruments)
(effective on serial number 2025A03556 and above).

Page 6-13, Table 6-3. Change the following part numbers as listed:

Old	New	
00339-04001	00339-04007	KNOB, DISTORTION RANGE
00339-04002	00339-04008	KNOB, INPUT RANGE
00339-04003	00339-04009	KNOB, OSC LEVEL
00339-04004	00339-04010	KNOB, UNITS
00339-04005	00339-04011	KNOB, TENTHS
00339-04006	00339-04013	KNOB, MULTIPLIER
0370-1099	0370-3054	KNOB, POINTER
0370-2994	0370-3055	KNOB, POINTER

CHANGE NO. 38 (applies to all instruments).

In Section V, Adjustments, make the following changes:

Page 5-2. Add paragraph 5-14d to read, "Set the frequency multiplier control to each range and verify that the voltage level at A1TP8 remains negative."

Paragraph 5-17. Under Equipment Required, Low Distortion Oscillator, (-hp- Model 339A) should read "(-hp- Model 239A)."

Page 5-3, Paragraph 5-17b. On the listing INPUT RANGE...3V, the "3V" should have listed beside it, "(+10dBV)".

Paragraph 5-17c should read, "Set the controls of the 239A signal source to obtain a 1kHz (1.0 x 1k) signal. Adjust the output level for a full scale meter indication of 0 dBV on the instrument under test."

Add a paragraph between 5-17g and 5-17h that reads, "Set the 239A level controls for a -10dB indication on the 3571A."

Page 5-4. Paragraph 5-17k should read, "Adjust the output of the 239A for a full scale meter indication on the unit under test."

Paragraph 5-17n should read, "Set the frequency of the 239A to 10Hz (1.0 x 10). Adjust the output level for a full scale meter indication on the instrument under test."

Paragraph 5-17u should heve added to the end of it, "This reading must be >-95dB."

Paragraph 5-18. Under Equipment Required, Low Distortion Oscillator, (-hp-Model 339A) should read "(-hp- Model 239A)".

Paragraph 5-18c should read, "Adjust the 239A signal source to provide a 10kHz, 1V signal."

Page 5-7/5-8, Figure 5-3. Switch the part designators and adjustment descriptions on A2R37 and A2R17 shown in the lower left corner of the drawing.

CHANGE NO. 39
(effective on serial numbers 2025A04006 thru 2025A04160)

Page 6-7, Table 6-3. Change the part number of A3Q100 from 1[illegible]-0458 to 1855-0269.

This change was made because the vendor discontinued the part.

CHANGE NO. 40 (applies to all instruments)
(effective on serial numbers 2025A04161 and above)

Page 6-7, Table 6-3. Change the part number of A3Q100 from 1855-0269 to 1855-0230.

This change was made because the input circuit has better distortion performance with a depletion mode MOSFET. This part should be used in all instruments.

Page 6-5, Table 6-3. Change the part number and value of A2R16 from 0757-0422, 909 ohms to 0757-0420, 750 ohms. Change the part number and value of A2R17 from 2100-3212, 200 ohms to 2100-0554, 500 ohms.

Page 8-19/8-20, Figure 8-16. Change the schematic value of R16 from 909 to 750 and that of R17 from 200 to 500.

This change was made to give control over a larger percentage of full scale deflection of the meter. This allows meters to be used from the full range of the meter specification.

CHANGE NO. 41 (applies to all instruments)

Page 6-5, Table 6-3. Under A2K1, change HOLD DOWN SPRING 1460-1581 to RELAY HIDDNSP 1460-1612.

Page 1-3, Table 1-1. In the **OSCILLATOR** section under *Distortion*, change the table of specifications to read as below:

10 Hz to 20 kHz	< −93 dB (0.0022%)THD
20 kHz to 30 kHz	< −85 dB (0.0056%)THD
30 kHz to 50 kHz	< −80 dB (0.01%)THD
50 kHz to 80 kHz	< −70 dB (0.032%)THD
80 kHz to 110 kHz	< −65 dB (0.056%)THD

Page 4-8, Table 4-5. Change the table to read as below.

339A Frequency	THD Specification
10 Hz	< −93 dB
100 Hz	< −93 dB
1 kHz	< −93 dB
10 kHz	< −93 dB
20 kHz	< −93 dB
30 kHz	< −85 dB
50 kHz	< −80 dB
80 kHz	< −70 dB
109 kHz	< −65 dB

Note: The change to this table reflects the specification change and a change in relative symbols which was an error in the original manuscript (-94 dB is less than, not >, −93 dB).

Page 4-10, Table 4-6. Change all "greater than" signs to "<". (See note above.)

Page 4-15, Performance Test Record, Oscillator Total Harmonic Distortion Test:. Change the table to read as below:

339A Output Frequency	Calculated THD	Test Limit
10 Hz	______	-93 dB
100 Hz	______	-93 dB
1 kHz	______	-93 dB
10 kHz	______	-93 dB
20 kHz	______	-93 dB
30 kHz	______	-85 dB
50 kHz	______	-80 dB
80 kHz	______	-70 dB
109 kHz	______	-65 dB

MANUAL CHANGES

-hp- MODEL 339A OPTION 001

DISTORTION MEASUREMENT SET

Manual Part No. 00339-90001

▌ New or Revised Item

How To Use This Change Sheet.

This change sheet, unlike most, is designed to be a supplement to your 339A Operating and Service Manual rather than a list of corrections or changes. Included is a description of Option 001 for the 339A along with specifications, performance test, replaceable parts, theory of operation, and schematics which apply to instruments with Option 001 installed.

Unless noted inside this supplement, specifications, performance test, and other data published in your Operating and Service Manual for the standard -hp- 339A will apply to Option 001 instruments.

Description.

An -hp- 339A with Option 001 installed is a standard 339A Distortion Measurement Set with two additional voltmeter input ranges. These ranges are .3mV and .1mV full scale. Measurements capabilities are from .1mV rms full scale to 3mV rms full scale in a frequency range of 10Hz to 80kHz, and from .001V rms full scale to 300V rms full scale in a frequency range of 10Hz to 110kHz.

When switched to the .3mV range, the voltmeter attenuator is set to 0dB. When switched to the .1 mV range, the voltmeter attenuator remains at 0dB and 10dB of gain is added to the input amplifier. This gives the required input for full scale deflection on the front panel voltmeter.

These changes in voltmeter range have been accomplished by adding two additional positions on S4 of the Analyzer/Power Supply printed circuit assembly.

Specifications.

Table 1-1a is a supplement to Table 1-1 in the standard instrument Operating and Service Manual.

Recommended Test Equipment.

Equipment listed in Table 1-3 of the 339A Operating and Service Manual is also used on Option 001 instruments. In addition, to allow Full-Scale Accuracy and Frequency Response testing, the equipment listed in Table 1-3a is needed for Option 001 instruments.

Table 1-1a. Specifications.

Voltage Range:			
standard:	1mV rms full scale to 300V rms full scale (−60dB to +50dB full scale, meter calibrated in dBV and dBm into 600 ohm).		
option 001:	.1mV rms full scale to 300 V rms full scale (−80dB to +50dB full scale, meter calibrated in dBV and dBm into 600 ohm).		
Accuracy (% of range setting):			
standard:	20Hz to 20kHz 10Hz to 110kHz	±2% ±4%	@ INPUT RANGE .001V to 300V
option 001:	20Hz to 20kHz 10Hz to 110kHz	±2% ±4%	@ INPUT RANGE .001V to 300V
	20Hz to 20kHz 10Hz to 30kHz 30kHz to 80kHz	±2% ±4% +10%, −30%	@ INPUT RANGE 1mV and .3mV
Internal Noise Floor:			
option 001:	Filter Setting	Noise Level	
	30kHz	6uV	
	80kHz	8uV	

Table 1-3a. Recommended Test Equipment.

Instrument	Critical Specification	Recommended Model	Use
Resistors	100k ohm 1% metal film 100 ohm 1% metal film	-hp- Part No. 0757-0465 -hp- Part No. 0757-0401	P P
P = performance test			

Operation.

The ac voltmeter section of the Model 339A Option 001 measures the true rms value of input voltages from .1mV full scale to 300V full scale in fourteen ranges. Frequency range of the meter section is 10Hz to 80kHz for the .1mV and .3mV input ranges, and 10Hz to 110kHz for the .001V to 300V input ranges.

Performance Test.

All the performance test given in the standard 339A Operating and Service Manual are valid for use on instruments with Option 001. The following test is added to allow verification of Full-Scale Accuracy and Frequency Response of instruments with Option 001 installed.

Full-Scale Accuracy and Frequency Response Test (Option 001).

Equipment Required:

ac calibrator (-hp- Model 745A)
100k onm resistor (-ho- Part No. 0757-0465)
100 ohm resistor (-hp- Part No. 0757-0401)

a. Set the 339A controls as follows:

FUNCTION	INPUT LEVEL
FILTERS	OFF (out)
METER RESPONSE	VU
INPUT RANGE	.1mV
INPUT/GND SELECT . . . . (center position)	DIS. AN/

b. Set-up the test equipment as shown in Figure 4-1a.

c. Set the AC Calibrator controls for an output of .1V @ 10Hz.

d. The 339A .1mV 10Hz meter indication should be within the Test Limits listed in Table 4-1A.

e. Using the AC Calibrator, verify the 339A Voltmeter accuracv for each .1mV Test Frequency in Table 4-1a.

f. Set the 339A controls as follows:

INPUT RANGE 3mV

g. Set the AC Calibrator controls for an output of 3mV @ 10Hz.

h. The 339A .3mV 10Hz meter indication shouid be within the Test Limits listed in Table 4-1A.

i. Using the AC Calibrator, verify the 339A Voltmeter accuracy for each .3mV Test Frequency in Table 4-1a.

Table 4-1a. Full-Scale Accuracy and Frequency Response Test Limits for Option 001.

Input Range & Input Level	FREQUENCY							
	10Hz	20Hz	100Hz	1kHz	10kHz	20kHz	30kHz	80kHz
	TEST LIMITS (±4%)	(±2%)					(±4%)	(+10%, −30%)
.0001V	000096-000104	.000098-.000102					.000096-.000194	.000070-00011
.0003V	.000288-.000312	.000294-.000306					.000288-.000312	.00021 -.00033

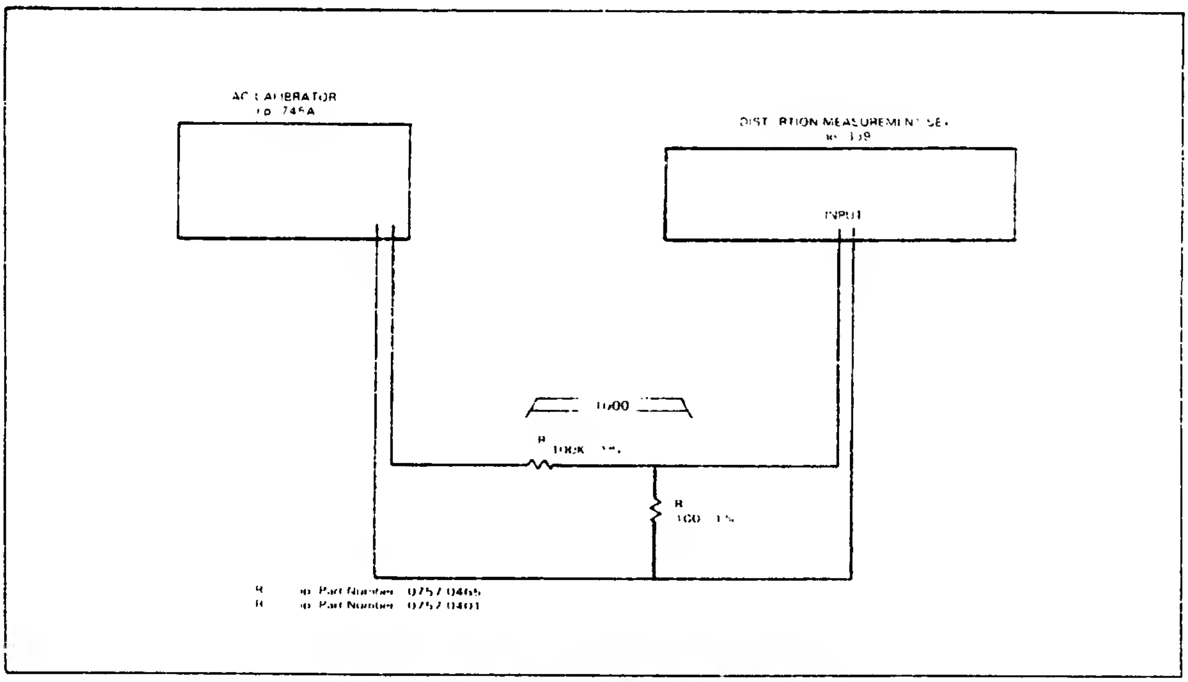


Figure 4-1a. Full-Scale Accuracy and Frequency Response Test Equipment Set-up For Option 001.

VOLTMETER PERFORMANCE (Option 001).

Full-Scale Accuracy and Frequency Response Test:

339A Input Level	339A Input Range	339A 20Hz Reading	30kHz Reading	Test Limits (±4%)
.0001	.0001			.000096-.000104
.0003	.0003			.000288-.000312

Input Level	339A Input Range	339A 20Hz Reading	339A 100Hz Reading	339A 1kHz Reading	339A 10kHz Reading	339A 20kHz Reading	Test Limits (±2%)
.0001	.0001						.000098-.000102
.0003	0003						.000294-.000306

Input Level	339A Input Range	339A 80kHz Reading	Test Limits (+10%, -30%)
.0001	.0001		.000070-.00011
.0003	.0003		.00021 -.00033

Replaceable Parts:

The -hp- 339A Distortion Measurement Set with option 001 installed uses an A53 Analyzer/Power Supply assembly instead of an A3 Analyzer/Power Supply. The boards are electrically the same with the following exceptions:

1. S4 has been changed to accommodate the two additional voltmeter input ranges. R127, 50.51Ω, R126, 10kΩ and C126, 100pF are included as part of the switch assembly.

2. C323, C324, and R314 have changed values.

Table 6-3a. Replaceable Parts

Reference Designator	-hp- Part No.	Qty	Description
A53	00339-66553	1	Analyzer/Power Supply Assy.
S4	00339-61914	1	Switch Assy, Rotary
	3100-1657	1	Switch, Rotary
R126	0757-0442	1	Resistor-fxd 10k .01 1/8
C126	0160-4801	1	Capacitor-fxd 100pF 100V
R127	0699-0053	1	Resistor-fxd 50.51Ω .25
	00339-04014	1	Knob Assy, INPUT RANGE
	1500-0580	2	Coupler, Flex
	3130-0552	1	Detent
C323	0180-0339	2	Capacitor-fxd 50uF 16V
C324	0180-0339		Capacitor-fxd 50uF 16V
R314	0683-1025	1	Resistor-fxd 1k .05 1/4

Theory of Operation

The Input Amplifier operation for instruments with option 001 is the same as that of standard instruments except that two simple modifications have been added to allow for the two additional input ranges.

First, a fourteen position switch replaces the twelve position switch of the standard instrument. This allows the output attenuation to go to 0d8 when either .1mV or .3mV input ranges of the voltmeter are selected.

Second, R127 (a 50.51Ω resistor) is included as part of the fourteen position switch to add 10dB of gain to the input amplifier when the .1mV input range of the voltmeter is selected.

Other A53 board changes:

The value of R314 decreased to 1k Ω to reduce 120Hz pulses picked up on the .1mV scale (due to imbalance in power supply bypassing).

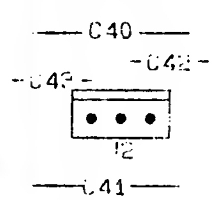
The values of C323 and C324 are increased to improve bypassing and stability in the 25kHz to 50kHz region.

C126 and R126 provide input compensation needed to prevent oscillation on the 0.1mV range with a high impedance source. They cancel the negative input impedance effects of U100.

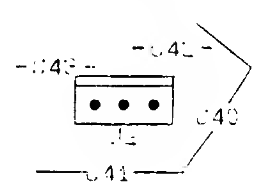
Figure 8-2A is a simplified block diagram of the input amplifier of Option 001 instruments. The schematic is a revised version of Figure 8-13 found in the standard instrument Operating and Service Manual. It shows the electrical modifications performed to generate an -hp- 339A Option 001 instrument.

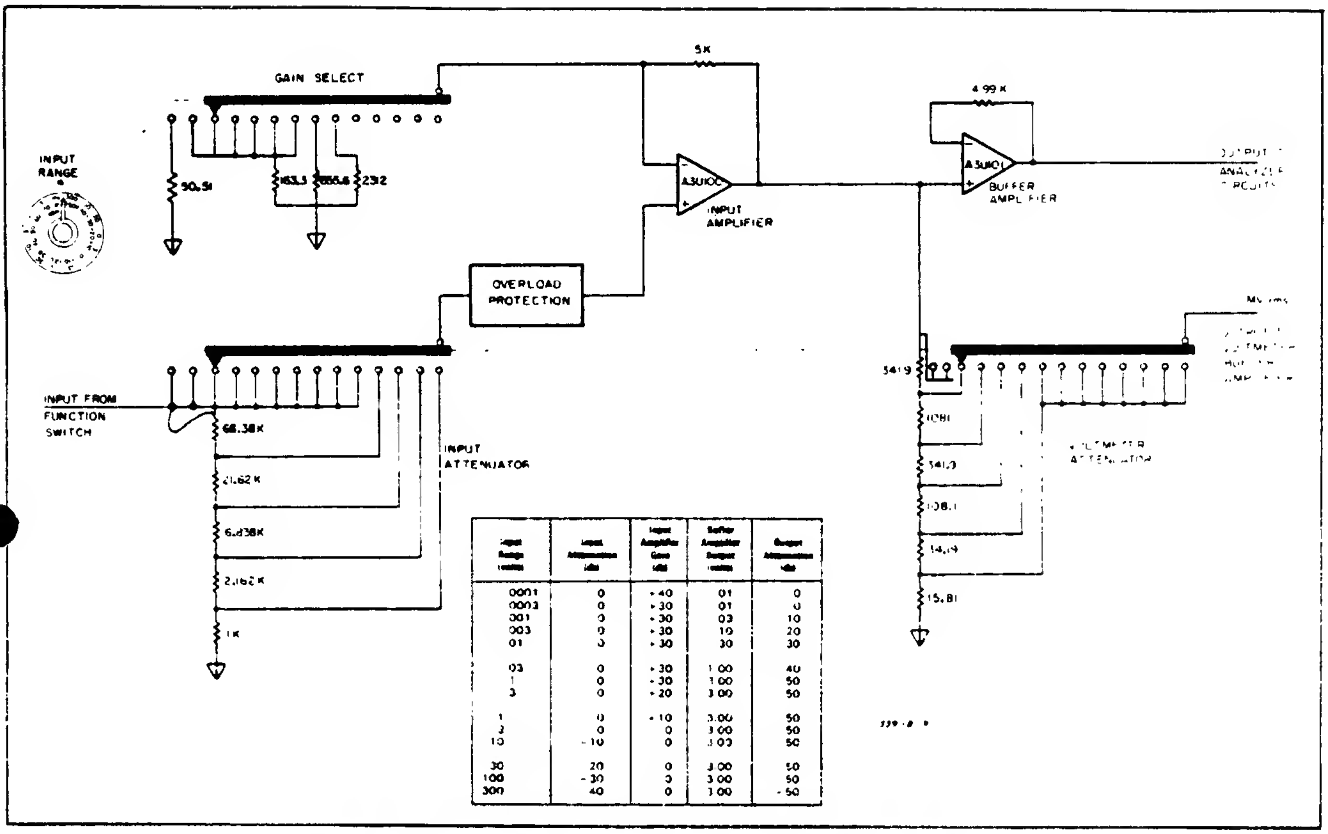
Other board changes:
Because a different (shaft) coupler is used on the INPUT RANGE assembly, C40 on the oscillator board needs to be repositioned as per figure below. When ordering a replacement oscillator assembly for the 339A option 001, use part number 00339-66551. This part will come with C40 in the proper place.

00339-66511



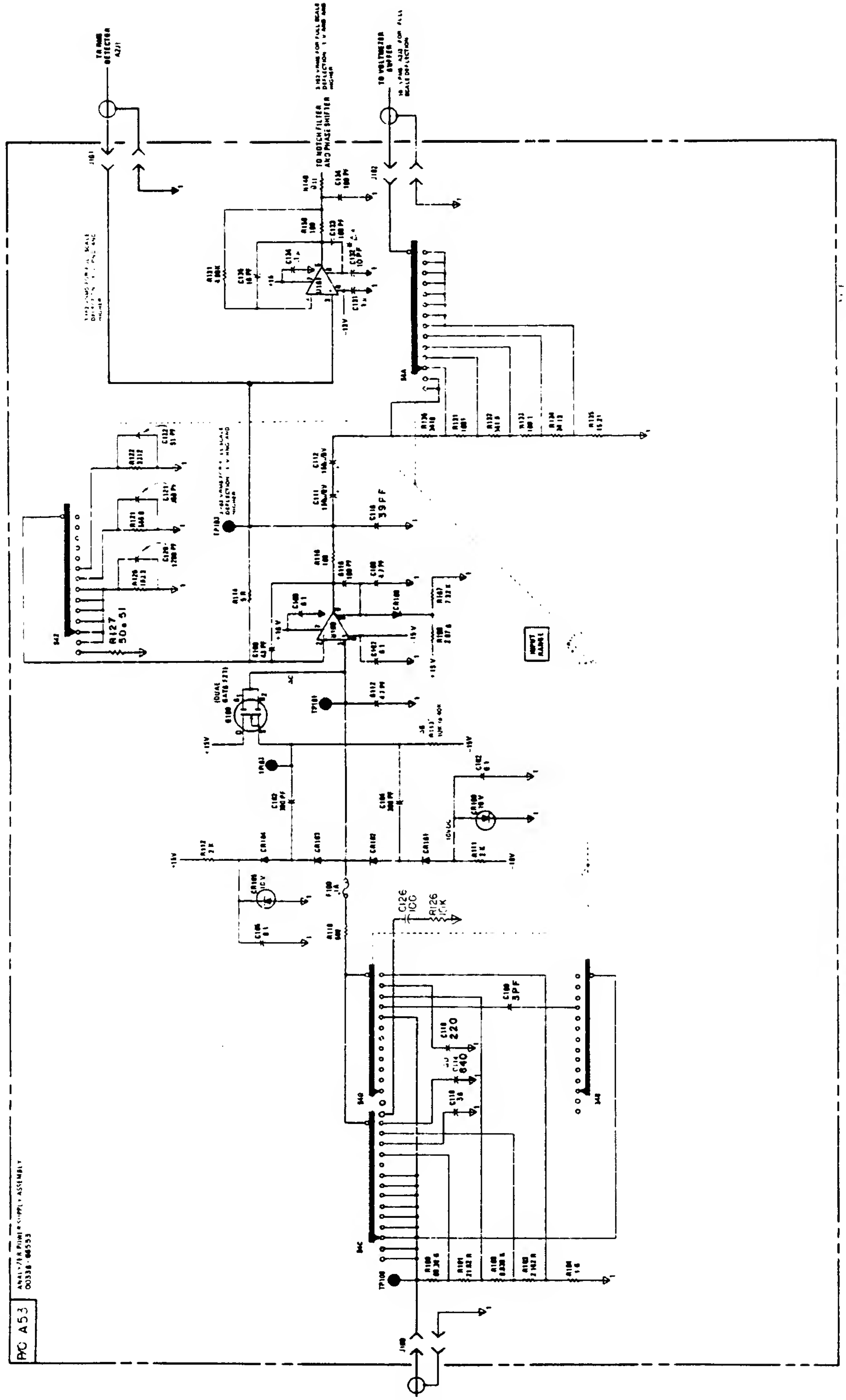
00339-66551





Input Range	Input Attenuation	Input Amplifier Gain	Buffer Amplifier Output	Output Attenuation
0001	0	+40	01	0
0003	0	+30	01	0
001	0	+30	03	10
003	0	+30	10	20
01	0	+30	30	30
03	0	+30	1 00	40
1	0	+30	1 00	50
3	0	+20	3 00	50
1	0	+10	3.00	50
3	0	0	3 00	50
10	-10	0	3 00	50
30	20	0	3 00	50
100	-30	0	3 00	50
300	40	0	3 00	-50

Figure 8-2a. Simplified Input Amplifier Schematic For Option 001 Instruments.



p/o Figure 8-13. Input Attenuator and Input Amplifier Option 001 Instruments.